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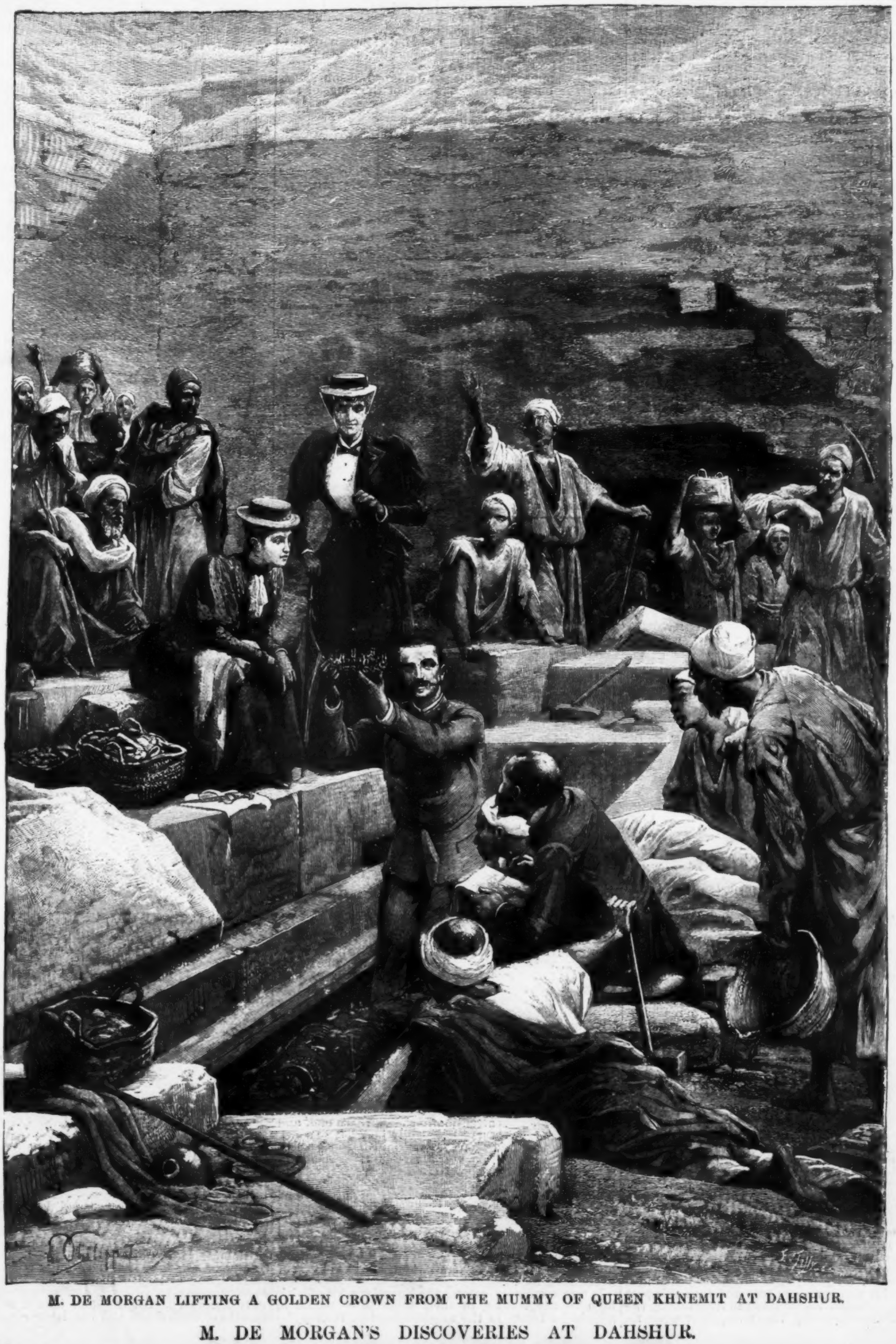


M. DE MORGAN LIFTING A GOLDEN CROWN FROM THE MUMMY OF QUEEN KHNEMIT AT DAHSHUR.

M. DE MORGAN'S DISCOVERIES AT DAHSHUR.

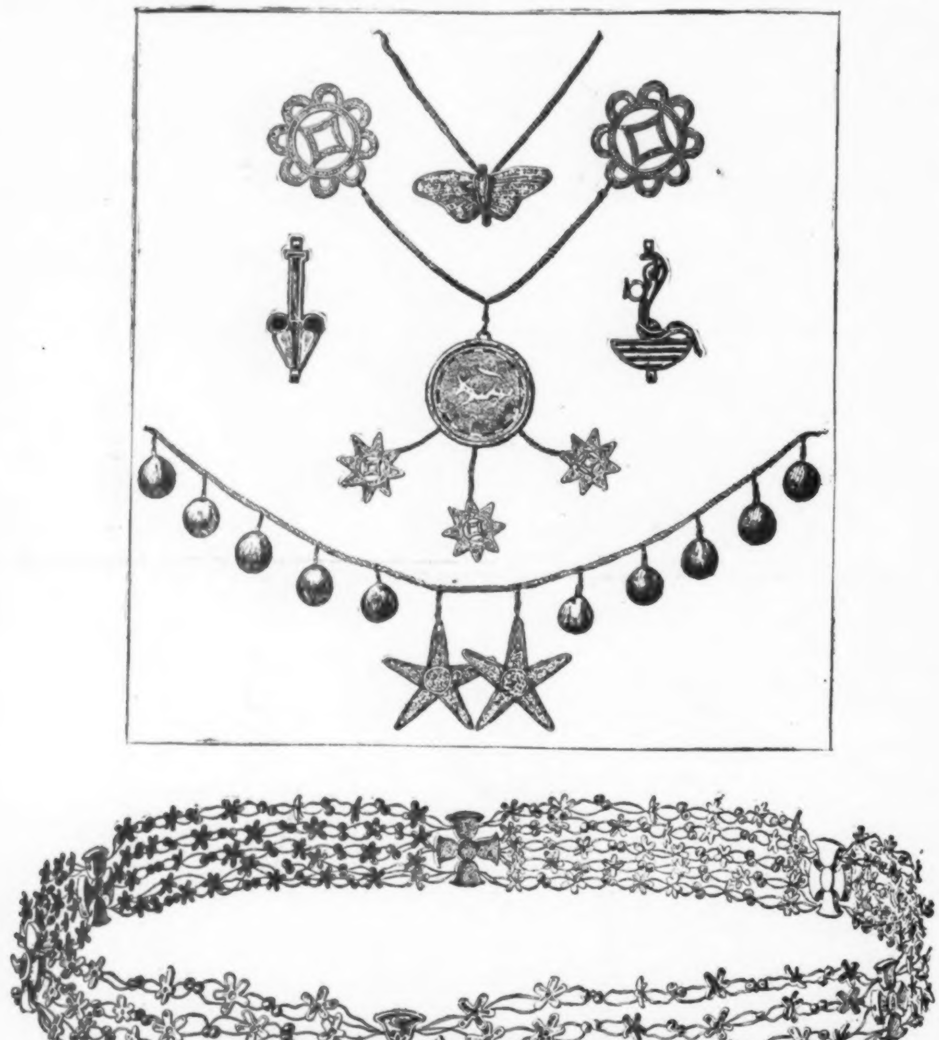
M. DE MORGAN'S DISCOVERIES AT DAHSHUR.

When the British army of occupation marched into Egypt, in 1882, that country most unexpectedly became the object of thought of every intelligent thinker in Europe and of every English speaking nation throughout the world. The diplomat, the soldier, and the politician each looked upon Egypt with a practical eye, and meditated what advantage could be got from it for the country which he represented, and, as every merchant knows that trade follows in the wake of military expeditions on a large scale into new countries, the commercial world believed that it saw its way to future advantage and benefit. But others besides the practical men were interested in the opening up of Egypt by the British—we mean the student of general history and the archæologist, not to mention the expert Egyptologist. Travelers of every civilized nation visited Egypt at intervals during the early years of this century, and some, like Belzoni, Wilkinson, Perring, Vyse, and Lepsius, have left behind them works on Egypt of the greatest value; many, however, have passed through the country and told us nothing of the conditions in which they found the monuments of its past history. Soon after the arrival of the British soldier in Egypt came the soldier's friends, and as they wanted to go about and see the country which he had been sent to put in order, it was found necessary to provide additional means of communication and transit. Though charmed with the country and the scenery and the climate, and all the beauties of sunshine and of clear air, the visitor soon remembered that Egypt had a past, and that she was the good mother who taught the rest of the world its letters, and how to read and write. He found that wherever he went he was confronted with the remains of a nation which, some 7,000 years before, had, like himself, sought to solve the mystery of its existence, and to pry into the life hereafter. Temples, obelisks, tombs, and statues all told the same story, and all proclaimed the intellectual power and civilized state of the ancient Egyptian; and the educated travelers who flocked to Egypt demanded with no uncertain voice that all the available information on these subjects should be given to them. But they were not the first seekers after knowledge of Egyptian lore, and they found that an attempt had been made to establish a museum of Egyptian antiquities (chiefly through the exertions of Mariette Pasha, its first director), to preserve from decay and from willful destruction the fast perishing remains of a glorious past.

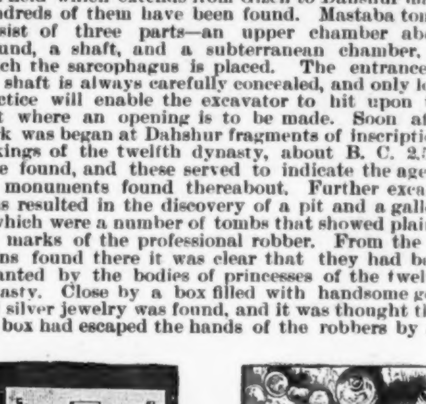
The first museum consisted of a comparatively small number of Egyptian objects, which were housed in some old post office buildings at Bulak, and the danger from fire was very great; part of the building, moreover, rested on a buttress which projected into the Nile, and it was generally expected that this part of it would be washed bodily into the river during the inundation. Subsequently the antiquities were removed to the palace at Gizeh, where they are well cared for, and where they are as safe as they can be in such a building. It is to be hoped that the new fireproof museum which is to be built in Cairo will soon be ready, and that no more anxiety on the score of fire need be feared. The first director of the museum was, as said above, Mariette; the second was M. Maspero, who added largely to its collection; the third was M. Grebant; and the fourth is M. J. de Morgan, whose recent discoveries at Dahshur we are about to mention. Since the apointment of this gentleman as Director General of the Service of Antiquities of Egypt he has undertaken and carried out a large number of important works, and his discoveries have kept pace with his labors. It is true that no work of such magnitude as the clearing out of the Temple of Denderah has been accomplished by him, but the general excavations which he has conducted and sanctioned have done much to extend our knowledge of Egyptian history and archæology. Unlike his predecessors, he has not endeavored to carry through all works single-handed, but his reputation has not suffered by this policy, while the Egyptian Museum at Gizeh and the visitor have got advantage.

During the winter of 1893-94 M. de Morgan paid a visit to the stony plateau on the west bank of the Nile, which lies a few hours distant to the southwest of Cairo, where stand the famous pyramids of Dahshur; a little to the north are the pyramids of the kings of the fifth and sixth dynasties, the "step" pyramid of Sakkara, and other important monuments. The whole district is full of tombs, and all scholars have admitted this fact; yet, strangely enough, no systematic excavations have hitherto been made throughout it. The northern end of the plateau was examined by Perring, who, however, obtained but few results; by Lepsius, by Mariette, and by Maspero. The discovery of the texts in the pyramids of Unas, Teta, Pepi I, Pepi II, and Mer-en-Ra are too well known to need notice here, and the history of Mariette's work at the Serapeum is known to all. Rightly conjecturing that his predecessors had discovered the most important remains that were to be found at the north of the plateau, M. de Morgan turned his attention to the southern end, and the results of his labors have fully justified his decision. A general idea of this portion of the plateau may be obtained from our illustration. Having arranged to live on the spot, so that the greatest advantage might result to archæology from his labors, M. de Morgan began to work with a large gang of laborers. He found it necessary to make first a general clearance of the sand, stones, and rubbish which had accumulated, partly through the decay of the buildings and partly through the excavations of other investigators, so that a plan of the walls which surrounded the pyramids might be made out, and any traces of tombs cut in the solid rock might be noticed.

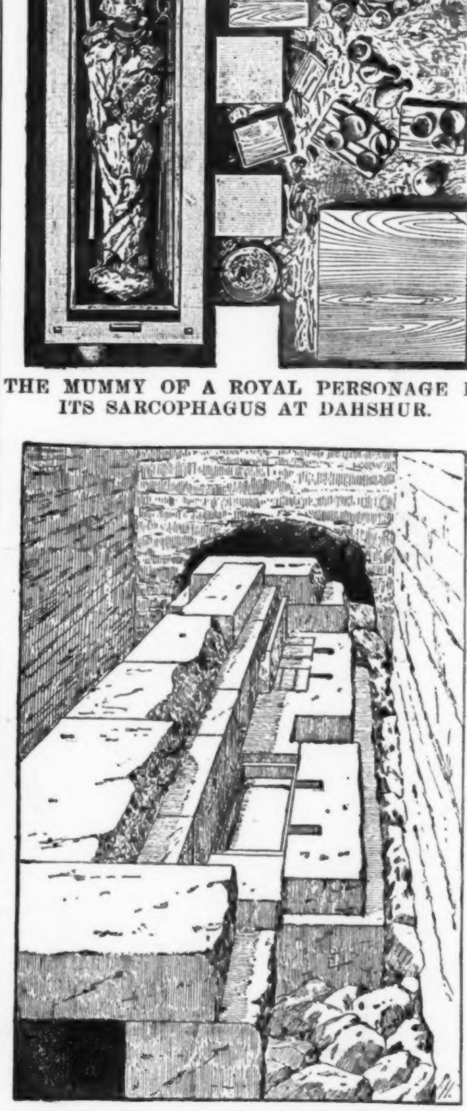
It was customary among the Egyptians for officials high in the service of their kings to be buried in rock-hewn tombs in the neighborhood of their pyramids. Such tombs have not the importance of pyramids, but they are, notwithstanding, of great value archæologically. To these tombs the name of mastaba has been given by the natives, and in the great pyramid field which extends from Gizeh to Dahshur many hundreds of them have been found. Mastaba tombs consist of three parts—an upper chamber above ground, a shaft, and a subterranean chamber, in which the sarcophagus is placed. The entrance to the shaft is always carefully concealed, and only long practice will enable the excavator to hit upon the spot where an opening is to be made. Soon after work was began at Dahshur fragments of inscriptions of kings of the twelfth dynasty, about B. C. 2,500, were found, and these served to indicate the age of the monuments found thereabout. Further excavations resulted in the discovery of a pit and a gallery in which were a number of tombs that showed plainly the marks of the professional robber. From the remains found there it was clear that they had been tenanted by the bodies of princesses of the twelfth dynasty. Close by a box filled with handsome gold and silver jewelry was found, and it was thought that the box had escaped the hands of the robbers by accident. It is more probable, however, that these gold and silver ornaments were removed from the mummies by the hands of priests or others who had cause to think that they would be stolen, and that they were hidden in a place where the professional thief, expecting to find nothing, would not search.



ANCIENT EGYPTIAN GOLDSMITH'S WORK DISCOVERED AT DAHSHUR.



THE MUMMY OF A ROYAL PERSONAGE IN ITS SARCOPHAGUS AT DAHSHUR.



SARCOPHAGI GALLERY AT DAHSHUR.

The work at the northern brick pyramid at Dahshur having come to an end, M. de Morgan next attacked the southern pyramid, the upper part of which had, however, been removed by the natives, who built the bricks into their houses. A wall ran round the pyramid, and between it and the pyramid were buried the royal children. At the northeast corner a tomb of very considerable importance was found, for it proved to be that of a royal personage called Au-ab-Ra, whose existence was hitherto unsuspected. Of the circumstances under which he lived and died nothing is known, but it is probably right to assume that he was a contemporary of Amenembat III, and that he either reigned with him or after him, but before Amenemhat IV ascended the throne. For a man who was at one time "King of Upper and Lower Egypt," his tomb was unusually mean. Having cleared out all the mastaba tombs on the north and northeast side of the pyramid of Amenembat III, M. de Morgan began work on the west side, and here, as elsewhere, success crowned his labors. All the ground was carefully examined, and at length the entrances to a number of shafts leading to subterranean sarcophagi chambers were discovered. An excellent idea of the size of the mouths of such shafts and the labor entailed in exca-

vating them may be gained from a glance at our illustration.

On February 15, 1895, M. de Morgan came upon an opening which led by an inclined plane to a gallery, and believing, for several reasons, that the tomb there had not been rifled, he removed the covering and laid bare the gallery to the light of day. On the following day, when room had been made to open the sarcophagi which had been placed there, the cover of one was lifted, and, to the great joy of all concerned, it was found to be tenanted by the mummy of the Princess Ha, which was ornamented with most beautiful golden jewelry inlaid with carnelian, turquoise, and lapis-lazuli. The fastenings of the collar and some of the smaller portions of the ornaments had become loose and had dropped by the side of the mummy into the coffin, but they had been wonderfully preserved by the dry stone chamber in which they were buried, notwithstanding the four thousand years which had passed since they were laid on the dead princess. In a small vaulted chamber the funeral offerings were found, together with the vases of unguents, etc., with which the double of the princess was intended to delight itself. When the second sarcophagus was opened, it was found to contain the mummy of the Queen Khnemit, who had been buried with most valuable articles of jewelry. Our illustration shows M. de Morgan in the act of lifting a magnificent golden crown from the head of the mummy of Queen Khnemit. Those who looked on at the removal of the jewelry from a great queen who had died more than four thousand years ago saw a sight which they will probably never forget. But, although the articles of jewelry in the coffin were numerous, and of every sort and kind which are characteristic of the epoch, the "find" which was made in a chamber close by is of greater importance, for here we have examples of the finest possible work of the ancient Egyptian goldsmith. The fine gold of which the crowns, pendants, beads, stars, etc., was made had been drawn out and worked into cunning patterns and devices, which would not, we think, be easy to imitate. The most beautiful effects are obtained by the inlaying of carnelian, lapis-lazuli and turquoise, and the patterns, though simple, show a mastery of the ancient craft of ornament which is almost incredible. Our pictures will afford an idea of the patterns, but only a sight of the objects themselves can enable the reader fully to realize the harmony and quiet beauty of the colors. Many visitors to the Egyptian museums of Europe and Egypt complain that expert knowledge is required to enable the visitor to appreciate the objects displayed, but in the case of the jewelry of the royal ladies who were buried at Dahshur the ordinary mortal needs no knowledge to tell him that what he is looking at is beautiful. Apart from the æsthetic value of M. de Morgan's labors at Dahshur, the historian and Egyptologist have need to be grateful to him; for he has not only explained the mystery which has hung over these half forgotten and wholly forsaken burial places of the members of the families of kings of the twelfth dynasty, but he has produced another royal name which must in future be added to the dynasty of Usertsens and Amenemhats. We are indebted to the Illustrated London News for the cuts and particulars.

THE CHILEAN BELLFLOWERS.*

VERY nearly related to the general smilax and asparagus, the Lapagerias belong to the order of true lilies, being really what we may call shrubby or climbing members of the liliaceous group, which includes some of the most beautiful of all our garden flowers. These charming plants were introduced nearly fifty years ago by Messrs. Veitch, of Chelsea, England, from Chile, where they were found by the late Mr. Tom Lobb, growing over shrubs and bushes at considerable elevations, and luxuriating occasionally even among the scoriæ of the mines.

The genus was named originally after the beautiful and illfated Josephine de la Pagerie, afterward Empress of Napoleon I, who is well known to have been very fond of plants and gardens in her time; and there is a tradition that her apartments at Fontainebleau are redolent of the subtile perfume of her favorite flower, the violet, to the present day. Both the red and white varieties fruited with exceptional freedom during the autumn of 1895 in the gardens at Straffan House, County Kildare, Ireland.

The seeds are borne in oblong, somewhat trigonal and fleshy fruits, each of which contains many large seeds embedded in soft pulpy matter, and that the seeds have been thoroughly fertilized is proved by their having germinated very quickly and freely after they were sown. The seed leaf is solitary, as shown in the accompanying sketch, and is followed by the second growth of a shoot from the young tigellum or root stock near the seed.

The plants at Straffan have been long established in large pots in a cool and shady greenhouse, the rafters of which they drape in a very graceful manner, but last season for the first time they fruited so spontaneously and freely that the inference is that the flowers had been fertilized by some special visitors in the shape of bees or flies. As a cool greenhouse or conservatory roof climber the Lapagerias at their best have but few rivals, as all admit who have seen them at Chelsea, in the Birmingham Botanic Gardens, at Straffan, and many other public and private gardens. The essentials to success seem to be a free, open, peaty compost and a cool and half shady position. As a rule, the plant is most luxuriant when planted out in an inner border, well drained and protected from the incursions of slugs, which show a special preference for the young asparaguslike growths or shoots as they emerge from the soil. That these plants can, however, be grown well in large pots the vigorous, free flowering and fertile examples growing at Straffan amply prove. But in specially sheltered localities these beautiful Lapagerias have proved to be not only hardy out of doors, but to have attained there to a vigor and richness of coloring not easily to be equaled by indoor or greenhouse specimens.

The old method of layering the Lapageria was a slow one, but one was at least sure of the variety, for, needless almost to say, there are some puny and pale colored forms in the market; indeed, there are at least two white varieties, the one very much larger and whiter and broader in leafage than the other, and generally to be preferred. Of rosy forms there are many, good, bad and indifferent, and the main difficulty in beginning their culture is to get a strong plant of a good form of a clear and bright color. One advantage of rearing seedlings is the fact that they possess exceptional vigor, and as they may thus be obtained in quantity, an opportunity will be afforded of trying these noble plants in deep, rich soils and in sheltered and shady nooks and corners in the open air. Wherever the coral berried Berberidopsis grows freely there would, à priori, be a good prospect of the Chilean Lapagerias also growing and flowering well. A cool and well drained compost seems to suit Lapagerias best, and I have found them particularly fond of nodules of red sandstone and clinkers, around which their roots cling with great tenacity. One drawback to open air culture will be the rapacity of the slugs and snails, but if these are kept off by zinc collars, lamp glasses or other means, there is no reason why Lapagerias should not be added to the list of choice open air flowering creepers or climbing plants in our gardens.

* By F. W. Burbridge, in the Garden.

SPRAY OF LAPAGERIA ALBA.

INTERMITTENT SPRINGS.

By WALTER C. GARRETSON.

ABOUT two years ago the writer contributed to the Indiana School Journal an article setting forth a new theory of the process of the intermittent spring.

Since that time he has given the subject further attention, and quite recently has performed experiments which he believes furnish sufficient proof of the correctness of the explanation there given.

It is the purpose of this paper to give a more complete discussion and to correct some errors which were made in the article referred to.

In this discussion, no reference is made to wet weather springs, or to springs depending on the tides for their intermittent flow. Only that class of springs is referred to which is described as having regular successive periods of activity and rest. This phenomenon has formerly been explained on the theory that an underground reservoir (A), Fig. 1, is connected with the surface, by means of a siphon shaped fissure (B) in the rocks, and that water constantly feeding into the reservoir gradually rises, both in the siphon and the interior of the reservoir, until it reaches the level of the highest point in the siphon, as shown by dotted line, e f, at which time the siphon, beginning to act, will continue to flow until the water has been lowered to the level, g h, or the inner opening of the siphon, it being understood that the capacity of the siphon is greater than the combined capacity of the inlets to the reservoir.

Let us examine this explanation in the light of both reason and experiment. It is self-evident that if the capacity of the inlet is equal to or greater than the capacity of the siphon, there must result a constant, not an intermittent, flow. On the other hand, if the capacity of the inlet is less than that of the siphon, will the level of the highest point ever be reached? Will not the water as soon as it rises to the level (d) begin to flow, and as soon as it has reached a level such as i, where the outflowing stream equals the inflow, will there not result a constant and equal flow? Experiment proves a constant stream as a result.

In performing this experiment, it was found that when the inflowing stream was so nearly equal to the capacity of the siphon as to bring it within the range of capillarity, the siphon would fill, and, the draw of the siphon being sufficient to increase the capacity beyond the range of capillarity, an intermittent flow resulted. The supporters of the old view were quick to seize this result as favorable to their theory. They maintained that perhaps just those conditions exist in nature—that the volume of the entering streams and the caliber of the siphon are so nearly equal that the

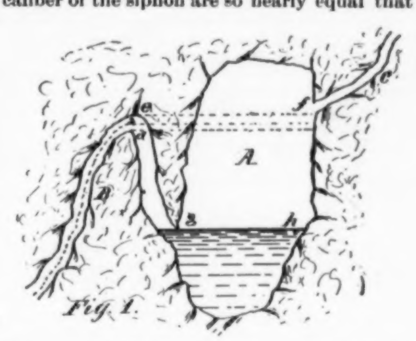


Fig. 1.

alternate establishing and breaking of capillary connection produces the intermittent flow.

But there are springs with the period of flow equal to or shorter than the period of rest, one of the most noted, at Paderborn, in Prussia, having regular six hour periods of activity and rest. To produce such a condition, it is necessary that the siphon have twice the capacity of the inflowing streams, or more than twice if the flow is shorter than the time of rest. It seems scarcely possible that the capacity of the siphon could be so much increased by capillarity and draw. And, too, the extreme improbability of such conditions, not to say impossibility, makes it unnecessary to give it further attention.

How, then, shall we explain the phenomenon as it occurs in nature? It is only necessary to call attention to one important factor which the old theory leaves out of account—air pressure.

To avoid the influence of air pressure, all experiments based on the old theory must be made with an open reservoir.

The cavity is practically airtight, except as air reaches it through the siphon or is carried into it by the entering streams. It has been held that the earth or rock, covering the reservoir, offers no resistance to the air and that as water enters the air escapes through the roof of the cavity just as readily as if it were an open reservoir.

By experiment it was found that a four inch covering of very coarse sand offered sufficient resistance to raise the water ¾ in. higher in the siphon than the level of the water inside.

With that point disposed of, let us refer to Fig. 2 and examine the influence of air pressure.

As soon as the water reaches the level, A B, thereby

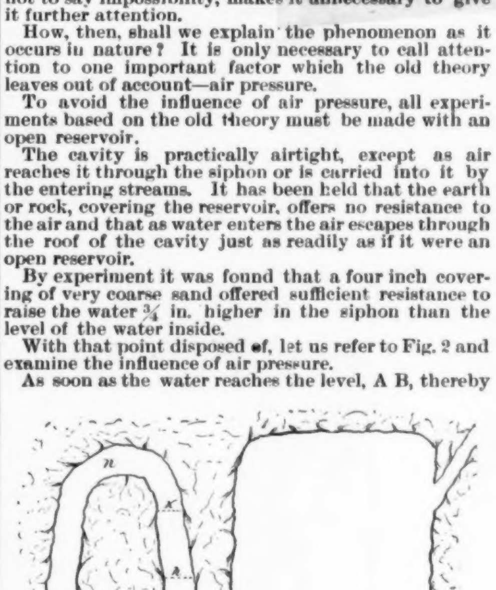


Fig. 2.

closing the siphon, the air above that level in the reservoir is imprisoned, and any further rise of water must result in increased air pressure. When at the level, A B, the water in the siphon and reservoir is under the equal pressure of one atmosphere, or 15 lb. to the square inch. As the water rises, the pressure in the siphon remains 15 lb., but in the reservoir it increases until at the level, C D, the pressure is 16 lb., the volume of the air having been reduced $\frac{1}{16}$. It is evident that with these unequal pressures the water cannot be at the same height in siphon and reservoir, but must stand sufficiently high in the siphon to balance the extra pound pressure inside. Since one atmosphere supports a column of water 34 ft. high, it is clear that the 1 lb. extra pressure will support a column of water in the siphon about 2¼ ft. higher than the level, C D, at e. When the water reaches the level, F G, the pressure is 17½ lb., requiring the water in the siphon to stand 5½ ft. higher, at h. When it reaches I J, it will support a column at k, and before rising to L M, the interior pressure will have filled the siphon at n. It will then continue to flow until equal pressure is restored, which will result when the water returns to the level, A B. The flow then ceases until the water is again forced over at n, and so on at uniform intervals.

In the experiment performed, the air chamber was small, so that a very small volume of water was sufficient to drive the water over the bend in the siphon, which in that case was above the top of the air chamber. The siphon was four times the caliber of the entrance pipe, and could have been much larger with the same result.

From the foregoing, it is evident that the water does not fill the siphon by rising to the level of its highest point in the reservoir, and not only that it does not, but that it cannot rise to such a height. The extreme height to which the water might be raised in the si-

phon has two limitations, viz., the head of the feeding steams and the degree of porosity of the rock or earth covering. The first limitation is necessarily absolute wherever the spring occurs, and may be easily determined. The second will vary greatly, owing to the character of rock or soil. If, however, four inches of very coarse sand will produce resistance enough to support a column of water ¾ in. high, certainly a covering of many feet of solid rock or compact earth will offer such a resistance that practically no air will escape in any probable case.

We are aware that some are yet unwilling to accept the new and discard the old explanation, but it seems to us that, since the old theory can only explain a condition which cannot exist, and the new satisfactorily explains every condition under which the phenomenon is found in nature, there ought not to be a doubt as to which theory is correct.

If any reader believes that he sees an objection to the theory, the writer will be glad to give it consideration and will endeavor to answer it.

Terre Haute, Ind.

WITH THE NORTHERN CHEYENNES.

By Lieut. HERMAN HALL, U.S.A., in the Northwest.

THE reservation of the Northern Cheyennes, at Lame Deer, Montana, is one of the wildest and most remote of the perfunctory homes given by the government to the Indians. It is sixty miles from the nearest railroad—a mountain fastness which, considered æsthetically, is of great value, but practically useless for the sustenance of thirteen hundred or more hungry souls. At the agency is a small post, built and garrisoned by the Twenty-second Infantry, which proves itself a wholesome restraint and constant reminder of the powers that be. To keep the Indians more contented within their narrow limits, they are sometimes allowed fete days on which they race their ponies to their hearts' content, feast to the fullness of their capacity, and dance. The soldiers, cowboys and ranchmen for miles around join in the sport on these festive occasions, and the motley assembly makes a most picturesque adjunct to the wild mountain scenery—the Indians in their bright colored blankets and beadwork, the soldiers in uniform, the cowboys in sombreros and buckskins.

CHEYENNE GIRL.

CHEYENNE IN WAR COSTUME.

CHEYENNE BRAVE.

The track where the races are run is watched over by the sacred sun pole, a tall sapling with a crotch, high up, in which rests an eagle's nest and, on its top, a buffalo head. The course is long, straight, uphill and uneven, with a square turn at the end. Twenty-five or thirty horses enter each race. The Indians ride bareback on scrubby looking little ponies, which seem to have a world of endurance and pluck. Those who ride and those who watch keep up a peculiar yell, which is not unmusical. They frequently race all day, wearing out one horse and taking another. The Indian trader, who has been many years with the Northern Cheyennes, often donates a feast—by no means the least important part of the day's celebration—to the Indians.

But the most characteristic and fascinating of all Indian customs is their dancing. To one who has never seen an Indian dance, it is difficult to convey a correct idea of what it is. It is not the pleasure of motion or of music that gives it inspiration. Its spirit is public and almost always religious or warlike. The scalp dance, buffalo dance, death dance, war dance and chief dance, are all explained by their titles. They are special dances for special occasions, as their names signify. The celebration of the sun dance, that most savage of Indian rites, is no longer permitted by the agents. The Cheyennes have a medicine dance, peculiarly their own, in which part of the tribe represent animals grazing, while the rest represent hunters who chase and bring down the make-believe game. Upon one occasion the people of the agency were somewhat concerned to see the Indians riding wildly around in a circle on one of the near buttes. There was an incessant discharge of firearms and the affair certainly looked formidable. It was, however, only a celebration of the horse dance, which occurs once in two years.

An old mission chapel, too large for the spiritual needs of the flock, has been utilized by the Indians for a dance hall. It is polygonal in form, with an opening to the sky, and a single door. They kindle a blazing fire in the center, bedeck themselves with war paint, which, in these degenerate days, consists of diamond dyes; don their war bonnets, tail feathers and ornaments of all descriptions, and take particular care that a small mirror is ready to hand. Crouched around the walls of this log Pantheon, the dancers make pictures from the Inferno. The weird light of the flickering flames reflected on their dark and sinuous bodies and savage, painted faces, the beat of the "tom-tom" in eerie, doleful measure, and the musicians' chant, all combine to make a picture that is fascinating and awesome. It affords an insight into Indian character that nothing else can give. The Omaha, or gift dance, is oftenest celebrated, owing to its pacific spirit and the inordinate love of the Indians for presents. In this dance two, and sometimes three, lines are formed and the dancers move forward, pass each other and turn and repass, but without any seeming regularity. They sit in a circle, rise, and dance at intervals.

Such incidents as the following occur frequently: During an interval of the dancing a young brave arose from his seat, with eyes cast down. His mother approached him and gave him a stick. She then led to his side an old chief, who addressed the assembly. Every one looked pleased except the knight of the doleful countenance. Then, from among the squaws, one came to his side and rubbed his face softly with her hands. The young man, who had lost a brother, sat down with bowed head. His mother had given him the stick—which was a signal for him to make a gift out of respect for his grief. The old chief had announced to the tribe that a horse was to be given to a certain squaw by the mourning youth, and the laying on of the maiden's hands had meant—"Thank you."

Some of the dancers are fearfully and wonderfully gotten up. The decorative devices are as numerous as the braves. One paints half his body lavender, the other half, green; another has one crimson cheek and one yellow, with a forehead of blue; another has a polka-dot body and a striped face. Porcupine quills, teeth of animals, feathers and horns, otter and beaver skins, bracelets and chains, fish and fowl, beasts and growing things—all nature, in fact, is called upon to furnish adornment.

The Indians are given their rations of beef fortnightly. Certain ones are selected as butchers; they shoot and cut up the cattle, for which they are allowed hearts, lungs, and livers as perquisities. The slaughtering pen is thick with blood. Here, early in the morning, are congregated all the squaws, young children and babes in arms. They come in bright array as to a county fair, and visit and gossip with their neighbors. Each man, woman and child is allowed one and one-half pounds of beef daily. The allotted portion is given on presentation of a ticket and is thrown out in the slaughtering yard, the dirt and filth of which is almost inconceivable. The squaws carry the meat to the little creek and wash it until the stream literally "runs red with blood;" then they begin to cut it up, eating the entrails and stomach lining raw and warm and feeding the children choice bits—the three-months'-old babies, their little hands and faces besmeared with blood, contentedly sucking the tenderloin. The scene is revolting in the extreme. Viewed in the light of Indian custom and savage nature, it is comprehensible; but as the best means of issuing meat to a savage people whom the government is trying to civilize, it seems incredible that such a scene is enacted twice a month—the moral effect of which must be of the most debasing kind. It cannot fail to keep alive the bloodthirsty passions that are dominant in the savage breast.

It is difficult for a white man to learn anything about the private life of the Indians. They are always either distrustful of him or utterly indifferent and do not care to enlighten him. Judged from the outside the family life among the Cheyennes is a happy one. The parents seem to love their children; they caress them and deck them out in all sorts of fantastic adornment, the little garments showing both skill and labor. When the children are ill, their devotion is remarkable. The squaws, who are quite comely when young, soon lose their roundness and become worn and haggard with hard work. The old women are dreadful looking hags, wrinkled in furrows and having snaky, iron-gray hair. The oldest woman in the tribe is ninety-nine. Poor old creatures, they receive little attention after they have outlived their usefulness. Care has to be taken by the agent that they receive their allotted rations. Although she does all the hard work and is a drudge, the squaw seems to occupy an important position in the family. She keeps the money, in most instances receives the issue of provisions, incites to war, and her voice is listened to in council. The age of marriage is very young among the Cheyennes, about fifteen years for both man and woman. The expression for marriage in the Cheyenne tongue is stealing a woman. After the suitor has been accepted there is little ceremony. The groom pays a few ponies for his bride, her family furnish a wedding feast, and the young people are man and wife. While courting, the young bucks throw a blanket around themselves, covering the head and leaving only one eye exposed. In this guise they are unrecognizable. They follow the young girls about their domestic tasks and, when they find them alone, make love to them. This custom seems to have been established to cover the bashfulness of the young buck and to save him from the ridicule of his fellows and the girl who scorns his advances. Twelve horses were offered for the belle of the tribe, the daughter of American Horse—a most generous offer, as the usual price paid is from one to six ponies, and the entire wealth of American Horse, who is the richest man in the tribe, consists of only twenty-three horses. The maiden is still unmarried, probably being held for a higher price.

To many, the "medicine man" is still an oracle. He strengthens his faith cure by giving all sorts of healing herbs. He goes into his tepee, builds a roaring fire, heats stones and pours on them a quantity of water, causing a great volume of vapor to be emitted; the tepee shakes, the manitous descend—sometimes even their voices are heard—and the medicine is made. Many of the Indians trust entirely in the agency doctor and some believe in both white man's and red man's medicine. On the side of a small butte overlooking the valley is the Cheyenne Medicine Rock. It is a peculiar, black rock, plainly of volcanic origin and twisted and gnarled, showing that it hardened from a viscid state. Surrounding it are pieces of old cloth, shells, trinkets and charms, all offerings to the god of medicine.

There is some idea of art among the Cheyennes—barbaric in the main, but dramatic. There is absence of detail and but one idea. Some of their favorite subjects are the Custer massacre, the buffalo hunt, and historic Cheyenne battles. The paintings are done on buckskin or white cloth, the natural color serving as a background. There is no perspective; horses and men are slapped on the canvas like postage stamps, yet the picture always conveys its meaning. When it is desired to portray motion or movement from one place to another, foot prints are marked along the route. One man often stands for numbers.

There are four great chiefs among the Cheyennes, and several lesser chiefs. White Bull, one of the great chiefs, is considered the most sagacious man in the tribe. He led General Miles up the Lame Deer Valley in 1877, where the Sioux under Lame Deer were in hiding. The troops descried the village from behind a high butte overlooking the present post and agency. General Miles and his command charged up the valley for a distance of four miles, and took the village by surprise. The Indians all fled to the hills. Lame Deer remained behind to don his war paint, and emerged from his tepee just as the troops entered the village. He signified a desire to parley; then, fearing treachery, he shot at General Miles, barely missing him and killing his orderly. White Bull, seeing the danger, shot and killed Lame Deer at the same

moment. On all occasions the old chief loves to recount this story to his tribe.

The word "Cheyenne" is popularly supposed to have come from the French chien. The Cheyenne language resembles that of none of the surrounding tribes. It is more musical and liquid. They call themselves "Sasisetas." While their language is poor in pronouns and qualifying words, the verb is inflected to an alarming degree. A Jesuit priest who labors among them claims to have found over three hundred and fifty forms of the verb "to see," in the indicative mode alone. The men of the Cheyennes hold the first rank for bravery and fighting qualities. In the early part of the century they drove the Crows, Kiowas and Apaches from the Tongue and Powder River Country. They are honest in that they always pay their debts. The Indian trader has credited them to the amount of fifteen hundred dollars and has never lost by them. Yet they steal cattle from the ranchers, if they have an opportunity, and lie as often as they tell the truth. The women of the tribe are famed for their modesty and virtue. Taking them all in all, they are creditable specimens of the Indian race and have retained more of their pristine ruggedness and strength than many tribes; yet they respond less quickly than their native wilds to the mighty march of progress. They are held in check only by force, and seem to have in their make-up an insurmountable barrier to civilization.

WITH THE NORTHERN CHEYENNES.

1. White Bull, a Cheyenne chief. 2. The Omaha, or gift dance. 3. A Cheyenne group. 4. A Cheyenne travois.

PERIODICAL COMETS DUE IN 1896.

By W. T. LYNN, B.A., F.R.A.S.

OF all the periodical comets whose orbits are known with some accuracy, two only are due to return to perihelion in 1896. One of these has been seen at seven previous returns, all consecutive; the other has hitherto been seen at only one appearance, unless a remarkable theory which was then started should be found on the forthcoming return to have been founded on fact.

The former of these two comets is that known as Faye's, because it was first discovered by the veteran astronomer, M. Faye, at Paris, on the 22d of November, in the year 1843. Its orbit was calculated to be a short ellipse, with a period of about seven and a half years, and it duly returned to perihelion in 1851, being first seen on that occasion by Prof. Challis, at Cambridge, on the 28th of November, 1850. It has also been observed at every subsequent return, and was last in perihelion on the 20th of August, 1888. Another return to that position will be due on the 19th of March next, but the comet was nearest to the earth in October last, and was seen by M. Javelle at Nice so early as the 26th of September, nearly six months before perihelion passage. This comet is a very faint object, and has never been visible to the naked eye. Its orbit is remarkable for its very small eccentricity, which amounts to only about 0·55. When in perihelion, the comet never approaches the sun so nearly as the greatest distance of Mars; when in aphelion, its distance somewhat exceeds that of Jupiter, and it was probably the attraction of that planet which first brought it into our system.

The other comet to which we referred was discovered by Mr. Brooks, of the Smith Observatory, Geneva, N. Y., on the 6th of July, 1889. Mr. S. C. Chandler, of Boston, United States, showed that it had made a very near approach to Jupiter three years before, which would have the effect of greatly changing its orbit. Now, a comet discovered by Messier, at Paris, more than one hundred and twenty-five years ago, on the 14th of June, 1770, was calculated by Lexell to be moving in an elliptic orbit, with a period of only five and a half years, but failed to put in an appearance when afterward due, so that it acquired the name of Lexell's lost comet. This failure, however, was explained as arising from violent perturbations produced by the attraction of Jupiter. The comet had in fact approached that planet in 1767 within a distance of only about one-sixtieth part of the radius of Jupiter's orbit, and this circumstance it was that brought the comet within view from the earth, which it approached in 1770 within a distance of little more than seven times that of the moon. It probably returned to perihelion in 1775 or 1776, but in a position unfavorable for observation; and in 1779, before another return was due, it approached Jupiter even closer than before, coming, indeed, nearer to that planet than the distance of his fourth or most distant satellite, and its orbit thus again undergoing a great alteration. Now, Mr. Chandler thought, from his calculations, that the comet discovered by Mr. Brooks in 1889 might be Lexell's comet, brought once more into visibility from the earth by the attraction of Jupiter in 1886. Dr. C. Lane Poor, however, made a reinvestigation of its motions, the result of which was not to confirm this theory. Mr. Brooks' comet was moving when discovered in an orbit with a period of nearly seven years, so that it will probably come into perihelion again in the spring or summer of the present year. It is hoped that it will be possible to obtain observations on that occasion, by which astronomers will be enabled to come to a definite decision with regard to the suggested identity with Lexell's lost comet of 1770. The orbit, as determined from those made in 1889, is even less eccentric than that of Faye's comet, and the perihelion distance from the sun is greater than the mean distances of some of the small planets, being more than twice as great as that of the earth. The eccentricity of the orbit amounts to only 0·48; this is the smallest of any known comet, with the doubtful exception of one denominated Tempel's first periodical comet, which was discovered by the late M. Tempel at Marseilles, in 1867, and observed at returns in 1873 and 1879, but not seen subsequently. It should be added that M. Schulhof has recently made some calculations which seem to show that the comet discovered by Prof. Swift in August last year (and not Brooks' of 1889) was identical with Lexell's. The period of Swift's comet is about seven and a quarter years, but at the next return in 1902 it is likely to be very unfavorably placed for observation, particularly in the northern hemisphere, so that we may have long to wait for the decision of this question.—Knowledge.

THE TRANSVAAL—ITS MINERAL RESOURCES.

By Prof. J. LOGAN LOBLEY, F.G.S., in Knowledge.

THE second half of the nineteenth century has been prolific in remarkable discoveries and developments, but, if for no others, it will always be a memorable epoch from the enormous additions it has given to the world's stock of gold from three continents. Its earliest years witnessed the development of the goldfields of California and Australia, then just discovered, with the sensational finding of large nuggets of gold in surface deposits; and its later years have been marked by the discovery of extraordinary auriferous rocks in South Africa.

A testimony to the African continent having for a long time been productive of gold is afforded by the name "Gold Coast," and many believe that much of King Solomon's golden store was derived from Eastern Africa, while there are undoubted remains of ancient gold workings both north and south of the equator on the eastern side of the continent. The reputation of Africa as a gold producing continent will, however, be chiefly based upon the recent discovery of the auriferous rocks of the South African Republic.

This portion of South Africa, commonly called the Transvaal, is an extensive region extending northward from the Vaal River (by which it is separated from the Orange Free State) to the Limpopo River.

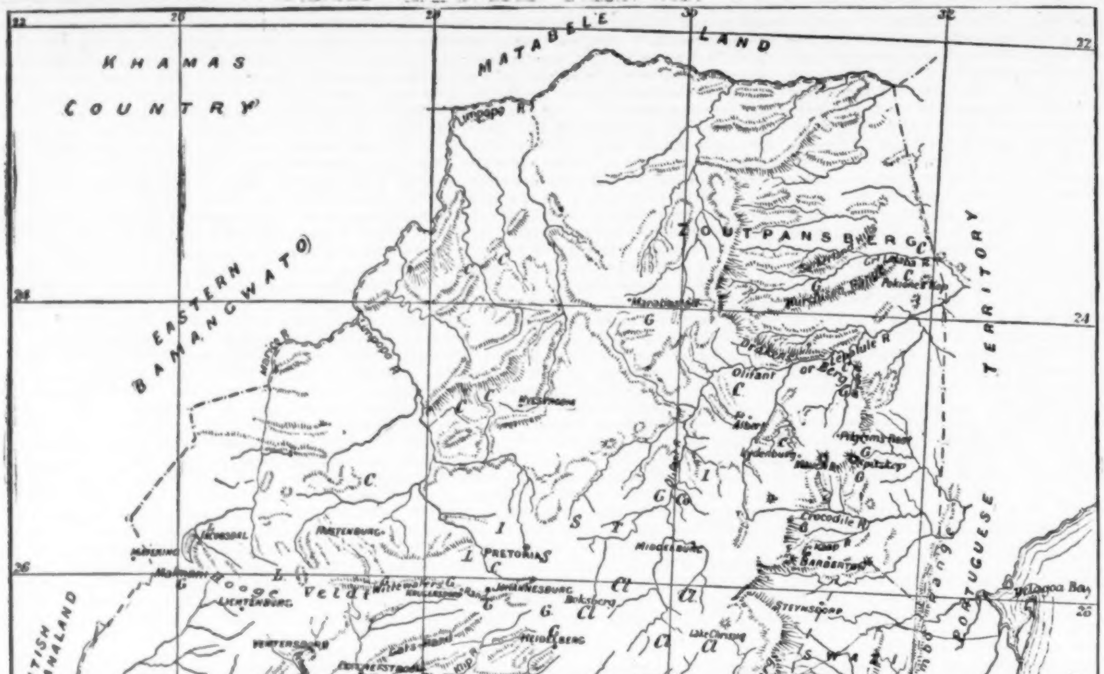
Bechuanaland lies on the west and the Lobombo Mountains and Portuguese possessions separate the Transvaal from the Indian Ocean on the east. Its greatest length is from the southwest to the northeast, and its eastern boundary is within forty miles from the sea at Delagoa Bay. With a very irregular boundary, the Transvaal has an extreme length and breadth of six hundred miles and five hundred miles respectively, and a total area of about one hundred and seventy thousand square miles, all lying between 22° and 29° south latitude and 25° and 33° east longitude.

In this extensive region gold has been found in many places since its discovery by Edward Button in the Kleinletaba in the year 1869. In the northern portion, between Olifant's River and the Limpopo, the widespread Zoutpansberg gold fields have been long worked, and, later, those of Lydenberg and the De Kaap Valley, in the east of the area; while, far to the west, and near the Bechuanaland frontier, there is the less important Malmani gold field. The southern portion of the Transvaal, however, lying between the Vaal River and Pretoria, has proved by far the richest auriferous region, from the occurrence in it of rocks running east and west along which are several series of parallel outcropping beds, called "reefs," which have been found to be, speaking generally, continuously gold bearing. The elevated district containing these auriferous rocks constitutes the now world famous Rand, or Witwaterstrandt, the gold yielding character of which was discovered in 1885; and the town of Johannesburg was founded on the Rand, at an elevation of five thousand six hundred feet above sea level, in the following year. But besides the Witwaterstrandt proper there are in this part of the Transvaal, moreover, the gold fields of Klerksdoorp to the west-southwest, Venterskroon to the southwest, near the Vaal River, and the Nigel and Heidelberg gold districts to the southeast of the Rand.

The enormously preponderating importance of the Witwaterstrandt district, as well as the relative yield of gold in the other districts, may at once be seen from the following statement from the State Mining Engineer's report on the gold production of the Transvaal for the year 1894:

Gold fields.	Gold bearing rock mined. Tons.	Gold. Weight. Ounces.	Gold. Value.
Witwatersrandt	3,062,767	4,948,924	£6,714,781
Heidelberg	25,618	52,685	172,340
Schoomspruit	182,448	78,358	264,724
Malmani	387	494	1,876
De Kaap	113,963	87,483	298,598
Zoutpansberg	26,613	10,611	38,104
Lydenberg	71,568	60,276	173,275
Vryheid	5,500	—	—
Carolina	150	13	44
Pretoria	—	6	23
Totals	3,489,015	2,239,865	7,667,152

Of this great aggregate production of gold in the Transvaal for one year, only 3,696 ounces, of the value of £12,806, was alluvial gold or that obtained from superficial deposits. These auriferous alluvial deposits



MAP OF THE TRANSVAAL, SHOWING PHYSICAL FEATURES AND MINERAL RESOURCES.

C. Copper. I. Iron. Cl. Coal. L. Lead. Co. Cobalt. S. Silver. G. Gold. T. Tin.

are at Blauuwbank in the Witwaterstrandt, at Barberton and Kaapsche Hoop in the De Kaap gold district, and at places in the Zoutpansberg and Lydenberg gold fields. The number of gold claims registered on December 31, 1894, was 3,929.

The greater portion of the southern part of the Transvaal is occupied by a plateau of highland called the Hooge Veldt, or High Veldt, which extends generally east and west, but trends toward the southwest; and from these uplands flow the streams that feed the Vaal and Limpopo Rivers, to the south and north respectively. The Witwaterstrandt is, indeed, the water parting between the two great river basins, the northern portion of the Transvaal being formed by the slopes, with low hill ranges, from the High Veldt to the Limpopo River.

Eastward the High Veldt rises to greater surface altitudes, until it attains the crest of a section of the Drakensberg range of mountains, running north and south, and culminating in the Maunch Berg, seven thousand one hundred and seventy-seven feet above the level of the sea. This range descends on its eastern side with a steep escarpment—prominent along which is seen the peak of Spitz Kop—to the great De Kaap Valley, about three thousand feet above sea level, that extends to the Lobombo Mountains, forming the eastern boundary of the state.

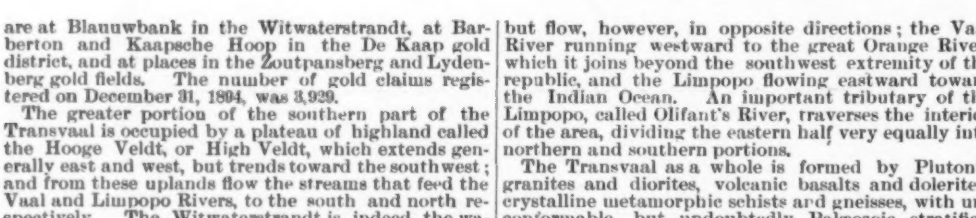
With the exception of the De Kaap Valley, the Transvaal consists of a portion of the elevated interior land of the continent of Africa that constitutes what is called the Central African Plateau, of which the Witwatersrandt is therefore a part and the Vaal Valley and the Limpopo northern valley are but depressions in the plateau.

The region generally is occupied by rolling grass covered uplands, with ridges of bare rocks standing above the general surface—in some districts at frequent intervals. This rocky surface character is given by a large amount of igneous rock in granitic bosses and dioritic and basaltic masses and dikes, together with the outcrops of the older stratified and metamorphic rocks of the country. Some of the dikes, from their position, have been subjected to less denudation than adjacent masses, and so form in places narrow ridges called "necks," which have sometimes a deep ravine on each side.

The whole area is intersected by river valleys formed by the streams (torrents at times) feeding the two bounding rivers, both of which rise in the Transvaal, but flow, however, in opposite directions; the Vaal River running westward to the great Orange River, which it joins beyond the southwest extremity of the republic, and the Limpopo flowing eastward toward the Indian Ocean. An important tributary of the Limpopo, called Olifant's River, traverses the interior of the area, dividing the eastern half very equally into northern and southern portions.

The Transvaal as a whole is formed by Plutonic granites and diorites, volcanic basalts and dolerites, crystalline metamorphic schists and gneisses, with unconformable, but undoubtedly Palæozoic stratified rocks; and these are succeeded by a later series of rocks, again unconformable. Over large areas the outcrops of these rocks are concealed by superficial deposits of varying thickness, giving a red soil immediately below the turf. The older stratified rocks have a general southerly dip and east and west strike. The dip is usually at a very high angle, sometimes even nearly ninety degrees, but commonly from forty-five to sixty degrees, though a few miles to the south of Johannesburg and beyond Eagle's Nest the beds are nearly horizontal. It is in these rocks that the auriferous beds of the Witwatersrandt occur.

Section S. to N. from the Vaal Valley across the Witwatersrandt. Length of Section, 60 miles.



W. Water Parting between the Vaal and Limpopo River Basins. 5. Basalt. 4. High Veldt Beds, Coal-bearing (Karoo Beds). 3. Klip River Series. 2. Quartzite Shale Series, with G. "Banket" (Gold-bearing Conglomerates). 1. Granite.

The word "beds" is used here advisedly, for, although the term "reefs" is the name locally and generally given to these rocks, they are unmistakably sedimentary beds, and contemporaneous portions of the geological formation in which they are contained. They are, therefore, of an altogether different character from the well known auriferous "reefs" of other gold regions, which are quartz veins traversing the massive rocks across their planes of original deposition.

The so-called "reefs" of the Rand, on the contrary, are merely certain beds of a quite conformable series of stratified rocks, which consequently have a common dip and strike, and may, therefore, be considered to be one geological formation. It is this fact that gives to the occurrence of gold in the Transvaal a unique character, and renders it, from a geological as well as from an economic point of view, especially interesting.

The massive rocks in which the gold bearing beds occur—the "country rock"—are, for the most part, hard quartzites, sandstones and bluish shales, and the whole formation has been called the "quartzite shale series." It is altogether of enormous thickness, estimated at three miles, or sixteen thousand or seventeen thousand feet. From the absence of fossils—or at least from none having as yet been found—there is great difficulty in assigning to this great series of stratified rocks (which have been correlated with the Table Mountain sandstone) any other than an approximate geological age; but from its general stratigraphical position with reference to the other South African rocks, and from its unconformability with overlying coal bearing formations, it is certainly of Palæozoic and most probably of Silurian age. The whole of the rocks of South Africa may be classified as follows in descending order:

		16. Superficial deposits.
Mesozoic.	Upper Karoo.	15. Volcanic rocks.
		14. Cave sandstone.
		13. Red beds.
		12. Molteno beds.
	Lower Karoo.	11. Karoo beds (Beaufort beds).
		10. Kimberley shales. Unconformability.
		9. Ecca beds.
		8. Dwyka conglomerate. Unconformability.
Palæozoic.		7. Quartzites.
		6. Malmani limestone.
		5. Bokkeveld beds (wanting in the Transvaal).
		4. Table Mountain sandstone.* Unconformability.
		3. Malmesbury schists.
		2. Gneiss, and
		1. Granites.

The auriferous beds or "reefs" are in a succession of series, each series having two, three, or more reefs, separated by the country rock of different thicknesses, ranging up to one hundred and fifty feet, while the reefs themselves have thicknesses up to six or seven feet. These reefs consist of conglomerates, in which rounded pebbles of white and tinted quartz are embedded in a quartzose matrix, which, although originally sandy and loose, has been, by the infiltration of silica, rendered a very hard and compact mass. To the conglomerate the name "banket" is given. The quartz pebbles range in size from that of a pea to stones a couple of inches in diameter. It is not, however, in the pebbles that the gold occurs, but in the hardened quartzose matrix, and through this it is disseminated in small particles—so small, indeed, that it is often invisible to the eye; but this is abundantly compensated for by its generally regularly continuous and not intermittent dissemination.

Associated with the gold—which is in a metallic or "native" state, and not as an ore, or chemically combined with some other element—are the following metallic minerals: Iron pyrites, with its variety, marcasite, hematite, ilmenite, magnetite, copper pyrites, blende, galena, and, more rarely, stibnite or antimonite, cobalt, and nickel. Of all these, iron pyrites is the most abundant. Rutile, zircon, corundum, mica, talc, and chlorite are also met with. Besides "free gold," there are extremely minute particles of gold contained in microscopical interstices of the iron pyrites, and which accordingly may escape amalgamation and chlorination, and even the searching cyanide of potassium, and so be lost to the miner. With im-

* The gold bearing rocks of the Witwatersrandt are assigned to this formation.

proved processes and methods the amount of gold thus lost has been greatly reduced, by which much poorer material is being rendered payable than was formerly the case.

Although the gold is not chemically combined with any other element, it is always mechanically intimately associated with other substances, and is therefore never obtained as absolutely pure gold. The proportion of "fine gold," as perfectly pure gold is termed, is here about from eight hundred and twenty to eight hundred and fifty parts per thousand, with from one hundred and twenty to one hundred and forty parts of silver, and from thirty to forty parts of other impurities.

Since the auriferous reefs crop out they can be worked to a certain depth from the surface, or without deep shaftings, and the earlier mines were along these outcrops. It is obvious, however, that if the reefs dip from the surface at an angle of forty-five degrees—the average dip—shafts at some distance from the outcrop in the same direction as the dip, if sufficiently deep, will strike the reef, and thus there are three kinds of levels: Upper, middle, and lower; but the lowermost levels as yet are only about one thousand feet deep, whereas workings at five thousand feet depth may possibly be attempted in the future.

In the older gold fields of Lydenberg and the De Kaap Valley the geological conditions are different from those of the Witwatersrandt, for the gold occurs there in thin "leaders," as they are termed, ranging from one-eighth of an inch to eight or nine inches in thickness, which cut through nearly horizontal more or less soft strata of a different geological age from that of the quartzites and conglomerate reefs of the Witwatersrandt. These leaders chiefly consist of siderite or carbonate of iron, and quartz, with much oxidized iron pyrites. At Spitz Kop as many as thirty such leaders have been recorded; and sometimes these, when in fine dove colored argillaceous shale, become very thin, and then are unusually rich, in some cases being formed of plates of solid gold from one to ten ounces in weight. Here, too, iron pyrites is abundant, sometimes in large crystals and groups of crystals many pounds in weight.

Again, gold is reported as occurring at King's Claim in a soft breccia of sandstone, shales, etc., interpenetrated by decomposed diorite; and in Swaziland, gold associated with native bismuth is found in the heart of quartz. In the Blyde River valley saccharoidal quartz is in parts richly auriferous, while at Kantoor "flour gold" is disseminated not only through quartz veins, but also through their inclosing decomposed diorites.

With geological conditions such as those that obtain in the Transvaal, it is evident that the total yield of gold will continuously increase with the increase of mining operations both in area and depth, until they are coextensive with the workable auriferous beds or reefs. Thus, with the establishment of new claims and the working of deeper levels, the annual output of the precious metal may be expected to show a yearly increase. What will be the ultimate limit of that increase it is impossible to say; but Mr. Hays Hammond, whose great practical knowledge of the auriferous deposits of the Rand is so well known, says he "would regard as well within the bounds of conservatism the prediction that the annual output before the end of the present century will exceed twenty millions sterling worth of gold."

The metallic riches of the Transvaal are not confined to gold.

Silver in association with copper and lead occurs in granitic rocks in several parts of the country, as near Malmani, Pretoria, Rustenberg, and north of Middleberg.

Copper ore occurs at various places near the upper waters of the Limpopo as well as in the northeast of the state, and with galena, sulphide of lead, in veins in granite at the Albert Mine.

Lead ores are mined in the western part of the state in calcareous rocks near the source of the Groot Marico, and at Hamerkop, near Jacobsdal, on the Klein Marico.

Tin ore has been found in alluvial deposits on the Swaziland borders, and there are thin stanniferous veins in the granitic rocks; but it has not yet been discovered in paying quantities.

Zinc blende sometimes occurs associated with galena.

Iron ores, hematite, limonite, magnetite, and iron pyrites, are abundantly distributed in small quantities.

Mercury ore, cinnabar, occurs east of Barberton; and cobalt and nickel, as cobalt bloom, smaltine, and nickeline, to the north of Middleberg.

Of non-metallic minerals, diamonds have been obtained just within the Transvaal, near Bloemhof on the Vaal River, and near its confluence with the Makwsi River. Only small stones, however, have been found, ranging from one to five carats.

Salt occurs in beds to the north of Pretoria, and also still further north beyond Olifant's River, in the Zoutpansberg district.

Although true limestones appear to be wanting in the Transvaal, there is a calcareous sandstone that on being burnt or calcined yields lime for economic purposes; and in one locality there are caves with stalactites, resulting from the dissolving out of the calcareous matter from the rocks above.

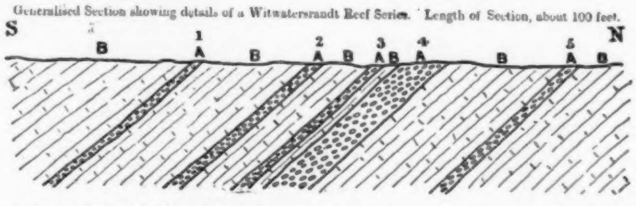
Coal is a most valuable product of any country, but especially so when motive power for machinery is largely wanted, and there is not a continuously abundant water supply in the rivers available for mills. These are the conditions that give to the coal bearing rocks of the Transvaal great importance.

The coal bearing rocks here are in the lower division of the very extensive South African formation called the Karoo formation. To this division the name "Molteno Beds" has been given, but its geological age has not yet been satisfactorily determined, since the formation as a whole, and the coal bearing rocks, as well as the coal itself, differ considerably from the carboniferous rocks and the coal measures of this and other countries; and the fossils, although similar, are so few and of such a general character that they do not afford a sure ground for correlation. The strata are almost horizontal, and so overlie the older uptilted rocks unconformably—indicating, therefore, a much later age. They form, as a rule, high ground, and constitute an extensive and continuous area of the High Veldt, and also occur as patches sometimes overlying the primitive granitic rocks.

The beds of coal are not continuous, as in the British coal fields, but in more or less lenticular masses, usually horizontal, but on slightly different horizons; though there are some seams now known to be continuous for miles. The thickness of the seams varies much, from a few inches upward. At Belfast there are three beds of a total thickness of thirteen feet. Though the amount of coal in the rocks of the Transvaal is very great, the quality does not appear to be high, some of the samples giving a large percentage of ash. The Belfast coal gave about twenty per cent. of ash, but that of the Douglas mine only eight per cent. There is also much iron pyrites in the shaly matter in the coal, rendering it a dangerous coal to stack in large quantities. It is generally very inferior to English coal, and unfitted for metallurgical purposes; but, nevertheless, it is sufficiently good for ordinary furnace coal for steam boilers, and this is the principal requirement of the Transvaal. Near the Vaal River, and near its confluence with the Klip River on the southern boundary, coal is worked, and also at Daggafontein and near the Witwatersrandt, at Boksberg, and the Brakpan colliery, where the output amounts to 13,000 tons a month.

With the addition of good building stone, furnished by its sandstones, a vast and varied store of valuable economic minerals available for the use of man is within the bounds of the South African Republic.

Generalised Section showing details of a Witwatersrandt Reef Series. Length of Section, about 100 feet.

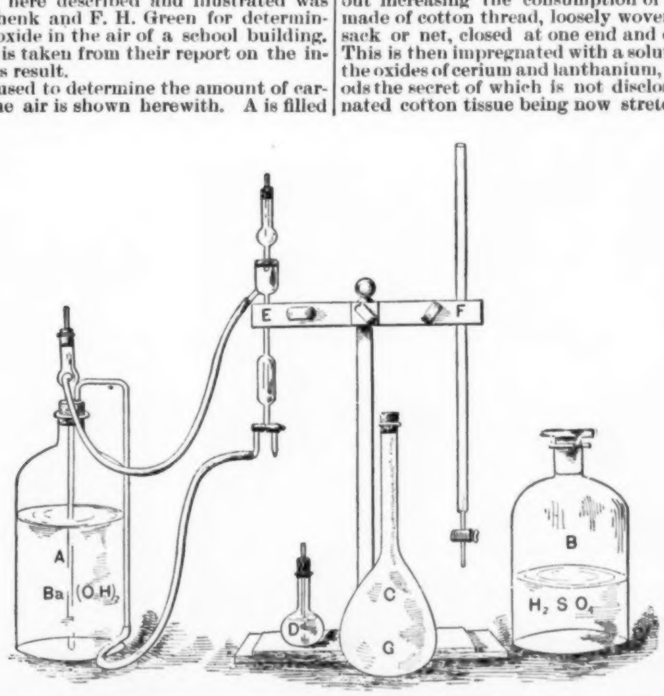


A. Banket, beds of Gold-bearing Conglomerate. B. Country Rock, Quartzites and Sandstones.
1. South Reef. 2. Middle Reef. 3. Main Reef Leader. 4. Main Reef. 5. North Reef.

DETERMINATION OF CARBON DIOXIDE IN THE ATMOSPHERE.

THE apparatus here described and illustrated was used by J. Weinshenk and F. H. Green for determining the carbon dioxide in the air of a school building. Their description is taken from their report on the investigation and its result.

The apparatus used to determine the amount of carbon dioxide in the air is shown herewith. A is filled with barium hydroxide, $Ba(OH)_2$, B with a dilute solution of sulphuric acid, H_2SO_4, in which 10 c. c. = 0·004198 gramme of H_2SO_4 and is equivalent to 1·54684 c. c. of CO_2 at 760 mm. pressure and 50 degrees Centigrade. C is a 1,000 c. c. flask in which the sample is obtained by displacing distilled water. D is filled with phenolphthalein and is used as an indicator for alkaline. Having obtained a sample of air in C, we put in 25 c.c. of $Ba(OH_2)$ by means of the pipette, E. By shaking well and allowing to stand for five minutes, the carbon dioxide in the air is absorbed. Then one drop from D is put in. If the air does not contain enough carbon dioxide to neutralize the $Ba(OH)_2$, the solution will turn red. Knowing the whole amount of $Ba(OH)_2$, we subtract from it the amount of $Ba(OH)_2$ it actually took to absorb the carbon dioxide. The remainder will be the equivalent of CO_2 in 1,000 c. c. of air. In this way we found with the fan running from 3·5 to 4 parts in 10,000 and with fan stopped from 5 to 7 parts in 10,000.



APPARATUS FOR DETERMINING CARBON DIOXIDE IN AIR.

USES OF MONAZITE IN EUROPE.

IN compliance with department instructions, inclosing copy of a letter from the editor of the Manufacturers' Record, at Baltimore, asking for information as to the use of monazite in this consular district, I have to report as follows:

Monazite—known in American mineralogy as "Eremit," and variously elsewhere as "Mengit" or "Edwardsit"—is a brown or reddish mineral which was originally found at Miask, in the Ural, but has since been discovered in Norway, Brazil, and still more recently in the United States, notably in North Carolina. It is a natural phosphate of the protoxides of cerium and lanthanium, two of the rare primitive metals. Monazite contains about 28 per cent. of phosphoric acid, 24 to 27 per cent. of the protoxide of cerium, 37 to 40 per cent. of the protoxide of lanthanium, and generally, traces of calcia, magnesia, and the oxides of tin. It is infusible before the blowpipe, but is soluble in hydrochloric acid, and upon these two qualities depends its value for the latest industrial purpose to which it has been applied in Germany—the manufacture of hoods for incandescent gas burners.

Until quite recently, the principal use of monazite in this country has been as a raw material for the production of cerium, lanthanium, and their various chemical derivatives. These are manufactured in Germany principally by two large and important firms, viz., E. de Haen, at Hanover, and E. Merck, at Darmstadt, near Frankfort.

Cerium, a gray metal of lamellar structure and high specific gravity, costs, in this country, $190 per kilogramme (2·2046 pounds), and its principal derivatives are the acetate, carbonate, chloride, nitrate, oxalate, sulphate, and the hydrated and anhydrous oxides of cerium. These products vary in value from $2.70 per ounce for the anhydrous oxide to the carbonate, nitrate, and pure oxide of cerium at $1.31; the salicylate, at $2.18; and the oxalate, at 41 cents per pound, respectively.

Lanthanium (also called lanthanum) costs, as pure metal, $6.80 for twenty grains; the chloride, $2.70 per ounce; the anhydrous oxide, $3.40; and the sulphate, nitrate and hydrated oxide of lanthanium, $2.70 per ounce, respectively. These values are here given to show that both metals and most of their compounds are so expensive that their use must be relatively limited. Metallic cerium and lanthanium are employed for incandescent purposes, and their derivatives are mainly of scientific, rather than industrial, interest.

But the most recent and important application of monazite, which has latterly greatly stimulated the demand for it in this country, is its use as an impregnating material for the hood or mantle of the incandescent gas burner invented by Dr. Auer, of Vienna, which is now made and sold in immense numbers by the Deutsche Gas-Glühlicht Gesellschaft, whose office is at No. 5 Molkenmarkt, Berlin.

The value of monazite for this purpose is due to its high degree of resistance to fire. The distinctive feature of the Auer burner is a hood or net of fine gauze, which surrounds the flame and by greatly increasing its incandescence produces a white, intense light without increasing the consumption of gas. This hood is made of cotton thread, loosely woven in the form of a sack or net, closed at one end and open at the other. This is then impregnated with a solution of monazite or the oxides of cerium and lanthanium, prepared by methods the secret of which is not disclosed. The impregnated cotton tissue being now stretched upon a wire frame and ignited, the cotton is burned away, leaving a skeleton of inorganic matter derived from monazite, in which each thread and mesh is perfectly preserved. This frail but highly refractory gauze-like hood is then inclosed in an Argand chimney, attached to the burner, and will last for several months.

Thus far, the Berlin company has obtained its supply of monazite from Norway and Brazil, the value of the imported mineral being governed by the percentage of available monazite contained, which varies from 1½ to 6 per cent. If the mineral from the United States is equal or superior to this, there would seem to be a good opportunity for its introduction for this purpose. A sample of the American mineral, with a certified analysis and specifications as to price, quantity offered, conditions of shipment, etc., if sent to Messrs. Edward Zeitz & Company, No. 1 Brandstwiete 20, Hamburg, will receive due attention.

The situation in Germany may therefore be summarized as follows:

Mr. E. de Haen, of Hanover, uses monazite in large quantities as a raw material for the manufacture of cerium and lanthanium and their various compound derivatives. He obtains this supply of the mineral directly from the United States.

Mr. E. Merck, of Darmstadt, also uses monazite for similar purposes. The origin of his present supply cannot be ascertained, but he would be glad to receive samples of the American monazite, with specifications as to its price and conditions of shipment. These may be sent to Mr. Merck direct, or to this consulate for delivery and further report.

The Incandescent Gas Light Company, No. 5 Molkenmarkt, Berlin, uses monazite in considerable quantity, but has thus far obtained its supply from Norway and Brazil. As an agent or intermediary between American producers and the Berlin company, or other possible consumers of monazite in Germany, Messrs. E. Zeitz & Company, whose address is given above, are respectfully recommended. It cannot be ascertained that any commercial firm in this country makes a specialty of the importation and sale of monazite, such as is consumed being purchased abroad and imported direct by the consumers.—Frank H. Mason, Consul-General, in United States Consular Report.

RADIOGRAPHY.

L'ILLUSTRATION, in its issue of January 25, announced Prof. Roentgen's discovery to its readers and reproduced a facsimile of one of the first prints sent to France by Dr. Voller. Since then, the scientists of the whole world have been multiplying the experiments in order to succeed in formulating a theory of the phenomena observed. The question is not yet elucidated. At Paris, however, a very interesting communication is expected from Prof. Leroux, of the High School of Pharmacy. At all events, we can now perfectly appreciate the importance of the discovery from a practical point of view. This is what I am going to point out briefly in showing, alongside of the results recently obtained, the simplicity of the methods employed.

Every one knows the Crookes apparatus, which is a spherical glass bulb in which as perfect a vacuum as possible is formed, and which is provided with two electrodes that permit of its being traversed by an electric current that fills the bulb with a peculiar light. The manufacture of these bulbs, which but recently constituted laboratory bric-a-brac, presents considerable difficulty. In fact, it is monopolized in Paris by a young engineer of the greatest merit, M. Seguy, of the High School of Pharmacy. M. Seguy was the first person in France to reproduce Roentgen's experiments, and it was he who obtained the prints presented to the Academy of Sciences on January 21.

One of our engravings shows us M. Seguy, in his laboratory, manufacturing a bulb. A glass tube is heated in a flame of hydrogen gas, and then, by a series of drawings accompanied with rotary motions, the operator succeeds in inflating the portion submitted to the flame. After this, a methodical blowing finally gives the inflation the desired form, now spherical and now ovoid. Three apertures are formed in the bulb, the two largest of which serve for fixing a small glass stopper carrying an electrode, and the smallest for exhausting the air from the bulb. To this effect, there is employed a very delicate apparatus consisting of a series of tubes partly filled with mercury and which may be seen in the left hand corner of M. Leroux's laboratory. After a vacuum has been formed, this orifice is closed by melting the glass by means of a lamp, and the bulb is then ready for operation.

The technique of the process is of wonderful simplicity. One of our engravings gives a representation of it from a photograph taken in the annex to M. Leroux's laboratory. It is hither that the medical experts bring their subjects, and it was here that a few days ago Dr. Labadie-Lagrave, the learned physician of the Salpetriere, in company with his pupils, effected the radiography of his own hand.

This annex is not very imposing. It is an apartment about twenty-five feet square, that was formerly used as a waiting room. Let us hope that the School of Pharmacy, which is the great center of radiographic studies, will obtain the few thousand franc notes necessary for a less rudimentary installation.

Upon the table there is a Ruhmkorff coil, which, through wires, communicates with a battery placed upon the floor. From a wooden bracket is suspended the bulb, which is itself connected with the coil by two other wires. Six inches beneath the bulb there is a photographic plate covered with black paper and surrounded by a wooden frame provided with a grating upon which is placed the object to be reproduced. M. Leroux devised this arrangement after discovering that the prints are more distinct when the object does not touch the plate. Upon this grating a woman places her hand. The current is made to pass, the bulb becomes illuminated, and without its being necessary to darken the room, the plate is impressed in thirty or forty minutes. It then suffices to develop it according to the ordinary processes in order to cause the image to appear.

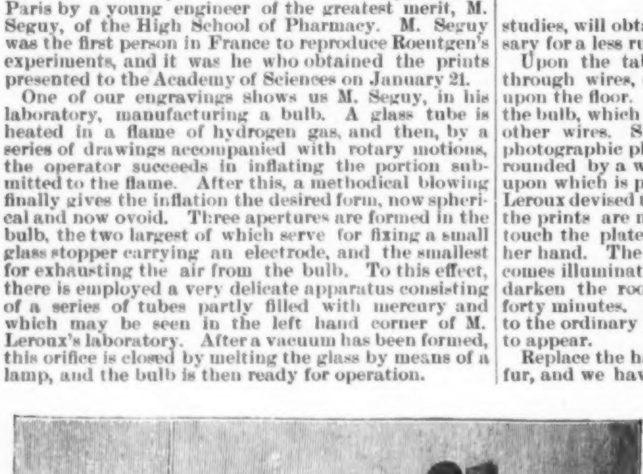
Replace the hand of a woman by a rabbit in flesh and fur, and we have a skeleton like that which we herewith reproduce from a print obtained by M. Albert Londe in the laboratory of researches of the optical society.

What is a more curious thing is that, if the bulb be coated with a black varnish, so that the light produced in the interior can no longer be seen, the plate is impressed just the same. From this it may be concluded that the light which passes through opaque bodies is invisible. It is a luminous radiation that escapes us, and is distinguished from the cathodic light, properly so called, which we perceive.

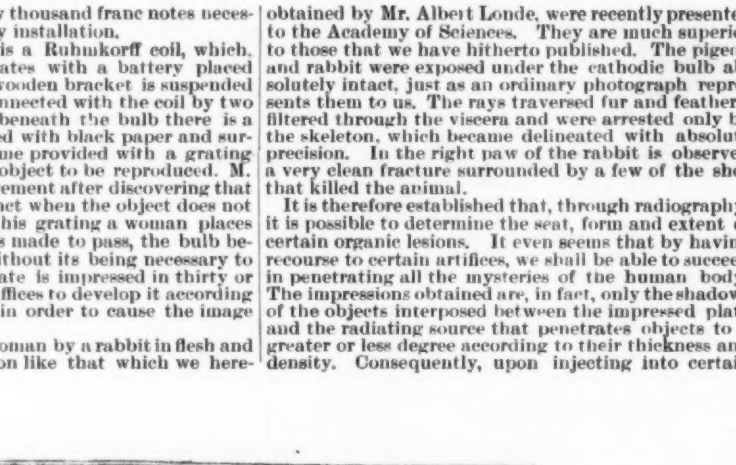
The two prints that we reproduce, and which were obtained by Mr. Albert Londe, were recently presented to the Academy of Sciences. They are much superior to those that we have hitherto published. The pigeon and rabbit were exposed under the cathodic bulb absolutely intact, just as an ordinary photograph represents them to us. The rays traversed fur and feathers, filtered through the viscera and were arrested only by the skeleton, which became delineated with absolute precision. In the right paw of the rabbit is observed a very clean fracture surrounded by a few of the shot that killed the animal.

It is therefore established that, through radiography, it is possible to determine the seat, form and extent of certain organic lesions. It even seems that by having recourse to certain artifices, we shall be able to succeed in penetrating all the mysteries of the human body. The impressions obtained are, in fact, only the shadows of the objects interposed between the impressed plate and the radiating source that penetrates objects to a greater or less degree according to their thickness and density. Consequently, upon injecting into certain

MANUFACTURE OF BULBS.



OBSERVATION OF THE SPECTRUM OF THE CATHODIC LIGHT.

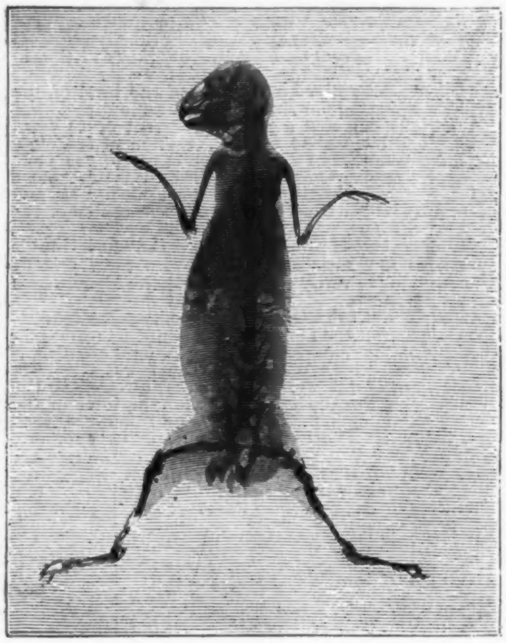


RADIOGRAPHY OF A HAND.

organs either metallic solutions that render the tissues opaque or fluorescent liquids that increase their transparency, we shall, at our ease, be able to modify the degree of traversability of the different parts of the body, and thereupon obtain a very distinct image of such or such a portion. Experiments of this kind that we cannot describe here have already been made in M. Leroux's laboratory and have given excellent results.

Better than this, no substance, probably, will arrest the X rays. It was thought, in fact, that such rays do not traverse any metal except aluminum. Now, M. Charles Henry has recently made a very curious experiment: Between the photographic plate and the bulb be interposed a pin covered with a large sou

PHOTOGRAPH OF A RABBIT.



RADIOGRAPH OF A RABBIT.

piece. He obtained as a print a black disk representing the shadow made by the coin which did not allow itself to be traversed by the invisible light. After spreading a layer of sulphide of zinc upon the sou, he began the experiment again. The sou this time allowed the X rays to pass, and the pin alone appeared in black upon the print.

Theoretically, then, upon covering bones with a fluorescent substance we shall communicate to them the degree of transparency necessary for certain observations. We cannot as yet say whether it will be possible to realize this artifice in practice. But, no matter! We already have a presentiment of a much simpler method of "opening up" the brain.

In all the prints that we have seen up to the present the bones appear, not because they cannot be traversed by the X rays, but because the time of exposure, sufficient to allow the light to traverse the flesh, is too short to permit it to traverse the bones. In fact, if we prolong the time of exposure for three or four hours, the bones will allow the X rays to filter through and will no longer appear upon the plate.

The observation of this new phenomenon has given rise to the idea of the following process: Here is a person, say, whose brain we desire to radiograph in order to know whether there are "wheels" in it! The skull intercepts the X rays, and if we exaggerate the time of exposure so as to render it transparent, the materials that it conceals, saturated themselves with light, will doubtless give no image. On another hand, it seems difficult to submit the bone to the same process of covering as in the case of M. Henry's sou. But simply project the radiation of a bulb upon the forehead, and let the cranium absorb this strange light for fifteen, twenty or thirty minutes and it will lose its opacity. We then come with another bulb and radiograph the contents of the skull as if they were exposed. Such is the fantastic experiment that is preparing at this moment.

Let us add that the arrangement employed for obtaining a print of any part of the body except the hand is also very simple. Do we wish to see what a man has in his stomach? Apply to the latter a photographic film covered with black paper, and then illuminate the back with a cathodic bulb. In this way the image will form upon the film without the motions of the subject causing it to undergo the least distortion.

It has been found, moreover, that upon increasing the power of the electric current we considerably diminish the time of exposure. In this case, it is true, we have to fear a breakage of the bulb; but it is permissible to suppose that we shall succeed in avoiding this difficulty. As we shall be able to operate upon the largest subjects, upon the sole condition of covering them completely with the X rays (for which it will suffice to project upon them the radiation of a certain number of bulbs), the best dressed and most perfectly wrapped woman will appear upon the photographic plate in as much of a state of deshabille as M. Londe's rabbit.—L'Illustration.

PHOTOGRAPH OF A PIGEON.

RADIOGRAPH OF A PIGEON.

THE PHOTOGRAPHY OF METALLIC OBJECTS THROUGH OPAQUE SUBSTANCES, BY MEANS OF THE BRUSH OF AN INDUCTION COIL WITHOUT A CROOKES TUBE.

By G. MOREAU.

ON repeating Roentgen's experiments on the photography of opaque objects by means of a Crookes tube, I have obtained, through a layer of cardboard of several meters in thickness, distinct proofs of different metallic objects (a steel key, the copper stand of a camera lucida, an aluminum wheel, etc.) All these proofs present the relief of the objects due to shadows, the orientation of which indicate that the active rays seem to come from the positive part of the Crookes tube.

I had the idea of substituting for the Crookes tube the brush of a strong induction coil, actuated by a medium current of six amperes. The brush was produced between a positive point and a small negative plate on one or more negative points.

The sensitive plate was placed, along with the object to be photographed, in the interior of a box of cardboard, completely closed. The box could be placed normally or parallel to the effluve, and separated from it by cardboard, or a plate of wood 0.0.5 meter in thickness.

A first observation, made with five brushes normal to the box, gave nothing appreciable.

Six other photographs were taken with a parallel brush and gave negative proofs, quite distinct and very intense.

All these proofs present a maximum of action at the level of the brush. They show thus that, as in the Crookes tube, the active rays come from the positive region of the oscillatory system.

The two photographs taken through wood indicate to me a notable absorption of the rays of a perceptible refraction, which I have not yet had the opportunity of measuring exactly.

The duration of the exposure varied from thirty to sixty minutes, and I hope to be able to reduce it in future, the intensity of the proofs indicating this possibility. I have tried to photograph the above objects with the brush of an electrostatic machine. Hitherto I have obtained nothing.—Comptes Rendus, cxxii, p. 238.

INCREASE OF THE PHOTOGRAPHIC YIELD OF THE ROENTGEN RAYS BY MEANS OF PHOSPHORESCENT ZINC SULPHIDE.

By CHARLES HENRY.

IF we apply on the surface of a photographic plate opposite to the gelatino bromide a layer of my phosphorescent zinc sulphide, of from 0·5 to 1 mm. in thickness, having care to reserve half the plate taken longitudinally, and if we expose in a frame provided with a curtain successive bands of this plate to the light of a candle for increasing times, we naturally obtain, after developing and fixing, a series of tints of decreasing intensities, but we find between the two halves of the plate (that which has received zinc sulphide on the glass and that which has not received it) a notable difference in the intensity of the gray tones; we see, e. g., on one of the proofs thus obtained, that the blackest half band of those behind which there is no zinc sulphide has the same intensity as a half band coated beneath with zinc sulphide, but exposed for only one-seventh of the time.

The ultra violet rays pass, therefore, through the gelatino bromide and the glass, and act upon the zinc sulphide, and the sulphide continues the reductive action by its own radiations, even on plates not sensitized to a yellowish green, then by its most refrangible radiations and by others, as will be seen at the end of this paper.

The Roentgen rays often behave quite differently in these conditions; if we expose to this radiation with the ordinary arrangement a gelatino bromide plate sulphureted in certain regions on the side opposite to the sensitive surface, we find on some plates no difference between the intensities of the parts the opposite side of which has been sulphureted and the intensities of those when the opposite side has been left untouched.

As the zinc sulphide is very easily saturated with the light of the Roentgen radiation, and as in certain cases this sulphide is acted on through the glass and the gelatino bromide, we must conclude that in the plates in question it is not the gelatino bromide, but the glass which plays the part of absorbent. This is a new demonstration of the difference between the Roentgen rays and the ultra violet rays, and the importance which must be ascribed to the glass and to its thickness in the cases where we wish to sensitize the plates to these rays by the application of zinc sulphide to the opposite side of the plate.

If we photograph by the ordinary procedures, by daylight, an image painted with phosphorescent zinc sulphide, the parts to which the greatest thicknesses of the sulphide have been applied appear on the negative in white, more or less intense. On examining the behavior of an object covered with phosphorescent zinc sulphide as regards the Roentgen rays, I have observed the remarkable fact of a striking increase of the photographic efficacy of the rays.

In a first experiment I photographed two fingers, the fore and the middle finger, the forefinger having been coated with sulphureted vaseline. It was found that all that portion of the plate which surrounds the shadow is blacker than the rest.

In a second experiment I placed on the photographic plate, wrapped in needle paper, an iron wire, and on this iron wire, in succession from the left to the right, a piece of 0·05 franc intact, a piece of 0·10 franc, coated with sulphide on its anterior surface, a piece of 0·10 franc coated with sulphide on its anterior surface, a piece of 0·05 franc coated with sulphide on its posterior surface, a 5-franc piece in silver coated with sulphide on the larger part of its anterior surface; lastly, a small optical trough, cylindrical, divided into two compartments, and containing in the right hand compartment a solution of quinine sulphate. The plate being developed and fixed after an exposure of forty-five minutes gives a very distinct shade of the iron wire behind the coin of 0·10 franc coated with sulphide on its anterior surface, a shade rather less definite behind the portion of the coin of 0·05 franc coated with sulphide on its posterior surface (the shadow of this piece coming up lighter than the others), a shadow less distinct also behind the portion of the 5-franc piece coated with sulphide (silver being under equal conditions more transparent than bronze); on the other hand, there appeared no shadow of the wire behind the sou left intact, and behind the portion of the 5-franc piece not coated with sulphide. Quinine sulphate did not exert any appreciable effect.

This experiment proves that it is possible, by coating with phosphorescent zinc sulphide bodies capable of absorbing Roentgen rays, to render visible on the photographic plate objects situate behind such bodies and otherwise invisible. The zinc sulphide fulfills the office of a supplementary actinic source; it converts into photographic rays Roentgen's rays, which are inert in this respect, a new proof of the complexity of the radiations emitted by the Crookes phial.

It is probable that other sulphides besides the phosphorescent zinc sulphide possess this property. I have not had the leisure to try them; but the great inalterability of the phosphorescent zinc sulphide secures for it an incontestable superiority over all other artificial phosphori.

I have likewise had occasion to verify, in the phos-

phorescent zinc sulphide, a hypothesis of Henri Poincaré. "May we not then ask ourselves if all bodies whose phosphorescence is sufficiently intense do not emit in addition to luminous rays the X rays of Roentgen, whatever may be the cause of their fluorescence?"

I have exposed for a second to the light of a magnesium ribbon a parallelopipedal ingot of aluminum, 0·145 meter long, 0·145 meter broad, and 0·006 meter thick, resting on a small support of blackened cardboard. On the outside, for a length of 0·06 meter, I coated it with zinc sulphide; then I left intact, externally and internally, a surface of 0·05 in length; lastly, I coated the ingot with this same sulphide internally on a surface of 0·038 in length, almost entirely shaded from the light of the magnesium, except at the edges. I placed between the ingot and the photographic plate, covered with a double sheet of needle paper, the above mentioned iron wire. After developing and fixing the negative presented a slight white silhouette of the wire on the rectangular black ground of the shadow of the ingot. The difference of the tints imperceptible in the non-sulphureted portion of the aluminum plate is more appreciable in the portion of the plate corresponding to the portion of the plate sulphurized below. In the same manner, after exposing the ingot to diffused daylight from three to five hours on a plate covered with a double sheet of needle paper, I obtained a very distinct veil of the plates visible, as far as the confines of the part sulphureted internally.—Comptes Rendus, cxxii, p. 312.

ON THE PASSAGE OF THE ROENTGEN RAYS THROUGH LIQUIDS.

By MM. Bleunard and Labesse.

In studying the influence which liquids may have on the passage of the Roentgen rays, it was necessary for us first to avoid the errors which might result from the transit of the rays through the vessel in which liquids have to be placed.

Glass is one of the substances which offer the greatest resistance to the passage of the Roentgen rays. On the other hand, vessels of wood or cardboard, covered with a layer of fatty matter, still oppose, in a certain degree, the passage of the rays. We have found that black paper, coated with suet, is, on the contrary, absolutely permeable. The sensitive plates wrapped in ordinary black paper, upon which are arranged squares of paper coated with tallow, are acted upon by the rays with the utmost ease, without any trace indicating upon the plate the arrangement which has been given to the little trough of greased paper.

If we expose to the Roentgen rays a sensitive plate previously wrapped in black paper, upon which are placed equal depths of liquid in small paper troughs coated with tallow, the white spots obtained upon the sensitive paper must be exclusively due to the liquids forming the screens.

We have hitherto made only summary experiments, but some of the results already obtained present, we believe, a certain interest.

Water is easily traversed by the rays.

Solutions of potassium bromide, antimony chloride, potassium bichromate, offer a very considerable resistance to the passage of the Roentgen rays, while solutions of sodium biborate and potassium permanganate are more easily traversed.

Colors seem to have no influence on the passage of the rays. Water colored with various aniline colors offers no resistance.

Our intention is to pursue these researches.—Comptes Rendus, cxxii, p. 527.

ON A MECHANICAL ACTION EMANATING FROM THE CROOKES TUBE ANALOGOUS TO THE PHOTOGRAPHIC ACTION DISCOVERED BY ROENTGEN.

By MM. Gossart and Chevalier.

We have the honor of pointing out to the academy a field of mechanical force manifested in the interior of the Crookes radiometer when fixed opposite to a Crookes tube.

We wished, in a course of public lectures on the radiations of electric lamps, to introduce Roentgen's X rays, the cathodic rays of Crookes, and the stratified light of Abria, which led Crookes to his discovery by the augmentation of the strata. It seemed to us logical to manifest at a distance the heating of the Crookes tubes by means of his radiometer. Our surprise was great on seeing the vanes of the radiometer not merely remain motionless before a very hot tube, but, even if once set in motion by means of extraneous heat, stop in front of the tube with a very fixed orientation, and after pendulum oscillations which are the more rapid as their distance from the tube decreases.

It is clear that we were confronted with a mechanical action due to a field of force erected in the radiometer, and antagonistic to that of heat.

We fell to work to verify the existence of this field of force around the Crookes tube, by studying it with the radiometer as to direction and intensity, and proving, upon some twenty substances, that this force traverses the same media, or is arrested by the same substances, as the X rays.

Furthermore, when once the radiometer is placed in the Crookes field, and only then, we found that the field, viscous in some degree, which stops the vanes, is modified by currents, especially by that of the exciting coil of the Crookes tube, modified by substances, electrized statically, and is lastly disturbed energetically by a magnet. On moving a magnet around the sides of the radiometer, we as it were unscrew the vanes, and render them anew obedient to the source of heat.

Thus we may cause, simultaneously or successively, the X rays, heat, and electrostatic, electrodynamic and magnetic forces, to enter into action upon the vanes of the radiometer.

It seems to us, therefore, that we have a convenient instrument with qualitative and quantitative indications for making new investigations on the radiations, still mysterious, which emanate from the Crookes tube—an emission following the exciting sources, the transmission, etc.

We therefore set up on a Melloni stand: 1. A Locatelli lamp. 2. The radiometer at 30 cm. from the lamp, so as to give about fifteen rotations per minute. 3. The Crookes tube, movable on its right axis by means of an index which shows, on a graduated circle, the various directions of the axis of the cathodic sheaf of rays.

As soon as we project the cathodic rays there is an arrest of the vanes, and not in consequence of a dissymmetry of the system, since we have seen sometimes the one and sometimes the others take the axial direction of equilibrium. Unfortunately, we have not yet been able to procure an apparatus with the vanes.

If we extinguish the Crookes tube, the stoppage persists for about five minutes in spite of the constant action of the Locatelli lamp. A fantastical and perhaps suggestive means of setting them again in motion is to project anodic rays, bringing the tube of the radiometer within a few millimeters. The vanes undergo at first an impulse in the direction opposite to the normal movement, which they afterward resume.

We have determined a first line of the level of the field by actuating our single Crookes tube with a large Ruhmkorff's coil and a primary current of 20 volts. This line is determined by the cessation of the stoppage; it is normal to the direction of one of the pairs of vanes; its maximum distance from the tube was 3 cm. in front of the axis (distance from side to side), and it coincided with the tube toward the center of the concave cathode.

On inclosing the tube with a circular photographic film, shut up in a paper case lined with metal letters, we were able to verify approximately the concordance of the two fields.

Relatively to the sources, we can only make definitely this remark: the inertia of five minutes in the stoppage, which is manifested with a Ruhmkorff coil, is not obtained with a Wimshurst machine.

Our experiments were particularly directed to the transparency of the substances for the force of the photographic action. The following substances were very pervious for both radiations: Pasteboard, ebonite, felt (layer of 2 cm.), sulphur, paraffin (1 cm.), wadding, etc. With equal thickness the action is propagated further through paraffin than through air.

As opaque bodies we indicate, in the order of decreasing opacity, lead, copper, aluminum, ivory, retort coke.

This note may be the point of departure of a series of researches which we hope to pursue to study the field of the Crookes tube with the radiometer.—Comptes Rendus, cxxii, p. 316.

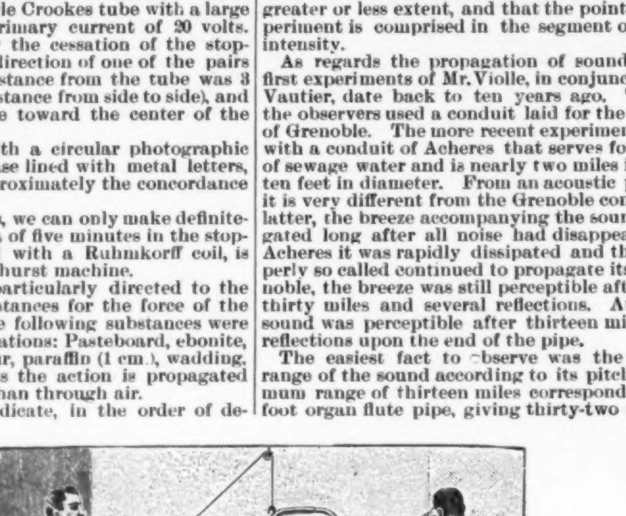
RECENT RESEARCHES UPON THE PROPAGATION OF SOUNDS.

More than forty years ago, Sondhaus showed that a lens of collodion filled with carbonic acid produced a concentration of sound. Afterward, Mr. Neyreneuf succeeded in showing refraction in a sheet rubber lens into which water had been introduced. Messrs. Perrot and Dussaud, two physicists of Geneva, after experimenting in the same direction as Mr. Neyreneuf, have recently made known an interesting verification of the laws of the refraction of sound, and have at the same time described an experimental arrangement particularly well adapted for use in elementary courses of lectures. On another hand, Mr. Violle, after some interesting researches upon the propagation of sound in pipes, has obtained experimental proof for certain delicate points of the theory, and brought forward a few new and unlooked for facts.

Messrs. Perrot and Dussaud, remarking that the numerous surfaces traversed considerably weakened sound, finally adopted the following arrangement. A cask filled with water is closed with a sheet of rubber firmly tied to the top in such a way as to be everywhere in contact with the liquid. Upon drawing off a certain quantity of the water, we cause a depression of the rubber, which remains adherent to the surface of the liquid and curved like the interior of a bowl. The meniscus then forms one of the faces of a concave lens convergent to the waves passing from the water into the air, since the velocity of the sound is greater in the liquid than in the gaseous medium that surmounts it. The sonorous source (a clock bell in the experiment under consideration) is placed in the axis of the cask. The experiment then consists in endeavoring to ascertain the conjugate focus of the source for a given curve of the meniscus. To this effect, one of the observers listens to the sound that reaches him through a tube attached to an ear trumpet, while the other explores the field by means of another trumpet. The first turns his back, so as not to be influenced by preconceived ideas. An endeavor is made, moreover, to cause the meniscus to preserve a constant curve by maneuvering, if need be, a small pump serving to exhaust the air that infilters through the joints and collects near the edges of the sheet of rubber. The first experiments showed that it was difficult, in displacing the trumpet in the direction of the axis of the apparatus, to discover where the sound was most intense. On another hand a great amplification of the sound was observed when, in a horizontal motion of the trumpet, the axis was intersected. By varying the curve of the meniscus, the experimenters obtained foci whose distances from the surface of the liquid was comprised between about 20 and 50 inches. The difference between the figures observed and the results calculated, starting from the curve of the surface, is feeble, but always of the same sign, and this may be attributed to the fact that the observers took the measurement at the mouth of the bell of the trumpet, while it would doubtless have been more correct to consider the observation as referring to an interior point. However, if we calculate the focal distance not by the mean curve of the meniscus, but, on the contrary, in dividing the latter into several zones, we shall see that the focus consists of a straight line of greater or less extent, and that the point found by experiment is comprised in the segment of the greatest intensity.

As regards the propagation of sound in pipes, the first experiments of Mr. Violle, in conjunction with Mr. Vautier, date back to ten years ago. To this effect the observers used a conduit laid for the water supply of Grenoble. The more recent experiments were made with a conduit of Acheres that serves for the disposal of sewage water and is nearly two miles in length and ten feet in diameter. From an acoustic point of view it is very different from the Grenoble conduit. In the latter, the breeze accompanying the sound was propagated long after all noise had disappeared, while at Acheres it was rapidly dissipated and the sound properly so called continued to propagate itself. At Grenoble, the breeze was still perceptible after a travel of thirty miles and several reflections. At Acheres the sound was perceptible after thirteen miles and seven reflections upon the end of the pipe.

The easiest fact to observe was the difference of range of the sound according to its pitch. The maximum range of thirteen miles corresponds to a sixteen foot organ flute pipe, giving thirty-two double vibrations per second. In measure as the sound rises its penetration diminishes, so that the fa of the small flute pipe loses all musical character at the end of about two miles, and the re flat produced by 4,450 complete vibrations per second is destroyed at 1,800 yards from the origin, where it no longer exists, except as a noise, and is extinguished at 200 yards farther along. But what is very curious is that the same sounds, existing as harmonics in a complex vibration, have then a great range and follow the fundamental sound.



PERROT & DUSSAUD'S ARRANGEMENT FOR THE STUDY OF THE REFRACTION OF SOUND.

The conduit acts as an analyzer. Theory indicates that there must exist at the same time a velocity of propagation and a coefficient of extinction a little stronger for acute sounds than for grave ones. But Mr. Violle's experiments show that the air, once deflected from its position of equilibrium by the passage of a grave sound, becomes more easily permeable to acute ones. There would seem to be a sort of friction at the start which, once overcome, no longer intervenes in the vibrations that immediately follow.

According to those observations, it is the grave notes that cause the acutest notes to return with them. Thus, the sound produced by 783 double vibrations does not return to the starting point when it is emitted directly by the trumpet, while it makes itself heard as the sixth harmonic of do^2. In the complex sound emitted by the violoncello, we perceive very well, on the return, the eighth harmonic, followed by the sixth, fifth, fourth and third.

In other cases, the second is still quite intense, but the seventh is constantly wanting. Such analysis is produced only when the emission is very pure.

The deformation of the sound, which, in the case of the vibration emitted by a musical instrument, consists of the degeneration of the sound into a noise, produces curious effects in other cases. Thus, when we ignite a small quantity of flash powder at the extremity of the conduit, we first hear a swelling sound, and then, in an instant, the wave returning after a travel of three and a half miles is so condensed that it produces absolutely the effect of a pistol shot. The cause of this singular phenomenon is doubtless analogous to that which brings about the return of the harmonics. The first waves that strike the air have to contend against its viscosity. They are deadened and retarded. Then the waves that follow find a more permeable medium, and advance, while, at the same time, their weakening diminishes. The simultaneous arrival at the starting point of the waves emitted during an appreciable time then occasions the powerful reinforcement of the sound shown in the experiment.—La Nature.

ENGINEERING NOTES.

A Helena, Montana, dispatch states that fire has broken out again in the Bozeman tunnel, on the Northern Pacific, and it is said to be beyond control. The original fire, which had been burning since last September, was put out only a short time ago, and it was expected the tunnel would be ready for use in ten day

One of the latest attempts at smoke prevention consists of a centrifugal fan which is placed so as to draw the hot gases from the uptake of the boiler. A stream of cold water is introduced into the center of the fan, where the centrifugal action sprays it out through a series of tubes, from which it flows through the bottom of the fan case into a receiver, where the solid particles are held in the water, the gases meanwhile passing off to the chimney.

The Lehigh Valley Railway has some eight-wheeled passenger locomotives at work which have a total weight of 90,000 pounds upon the driving wheels. The total weight of the engine is 128,500 pounds, the truck carrying 38,500 pounds. A load of 45,000 pounds upon a single axle was considered an impossibility only a few years ago, and it is only exceeded to-day in single driver locomotives, the highest probably being that of the new Philadelphia & Reading locomotive for express service.

The Standard Iron and Steel Company, of South Boston, are manufacturing what they call wrought iron castings. The process is carried out in a Siemens-Martin furnace, using crude petroleum, in which 20 per cent. of pig iron and 78 per cent. of scrap wrought iron are melted, 2 per cent. of a special composition being introduced when the iron has reached the proper fluidity. The quality of the resultant castings may be varied by changing the above proportions, and they are said to be practically free from blowholes.

The Southern Pacific Company have recently erected a plant which is something of a novelty in connection with railroad shops. It consists of a rolling mill of one train of 12 in. rolls, which has been put up for the purpose of utilizing railroad scrap iron. The scrap is cut up, piled and heated in a blooming furnace and then forged into slabs, which are again heated and then rolled into railroad shapes, such as are suitable for spikes, bolts, nuts, fish plates, etc. The annual production is about 11,000 tons, at a cost of half a cent per pound.

The Philadelphia & Reading Railroad is soon to place in service the fastest regular passenger train in the world. It will run from Philadelphia to New York in one hour and forty-five minutes, or at the rate of 58·2 miles an hour. The train will consist of a parlor car, a combination car and a first-class coach, the total weight being 100 tons. It is significant that the engine selected for this fast service will be a single driver compound—a type which has lately been introduced on this line. The single driver, though common in England for express service, is a novelty in modern American practice. American master mechanics who favor the six coupled locomotive for high speed will watch this experiment with close attention.

The Ansonia Brass and Copper Company give the following results of tests upon the strength of Tobin bronze, which, it will be remembered, was the metal of which the underwater plates of the yacht Vigilant were made: Tobin bronze rolled into plates ¼ inch thick has an average tensile strength of 79,145 lb. per square inch and an elastic limit of 53,787 lb. Rolled rods ⅝ inch diameter averaged 79,600 lb. per square inch, with an elastic limit of 54,257 lb. Drawn wire No. 4 B. & S. gage averaged 103,896 lb. tensile strength; No. 8 averaged 112,100 lb., and No. 14 gave 130,416 lb. The weight of a cubic inch of the metal is 0·3021 of a pound, being lighter than copper. In torsional tests rods ⅛ inch diameter, etc., and 1 inch long supported a strain of 328 lb. at the head of a lever one foot long and twisted 2·67 degrees at the elastic limit and 92·2 degrees before rupture. Pieces ¾ inch diameter and one inch long gave an ultimate crushing strength of about 180,000 lb.

The northernmost railroad in Europe, says the Railway Review, is the Swedish state trunk line from Langsell to Boden, upon which work has been proceeding from 1887 to 1895, and which has a mileage of about 310 miles. The line passes through vast forests and crosses the Angerman River and several other large rivers. The country is only in a few places cultivated and very sparingly inhabited. The preparatory work commenced in 1883, and was attended by considerable difficulties, as there were several lines under discussion, and the various lakes and rivers over which the line had to be carried also necessitated careful investigation. The result of protracted surveys was, however, a reduction in mileage of some 45 miles. The whole line, with rolling stock, etc., will cost about 26,000,000 kr., or about £1,450,000. The earthwork comprised about 5,706,000 cubic meters and 126,000 cubic meters of rock blasting. There are altogether 78 bridges, the largest of which is across the Angerman River; it is about 900 ft. long and 125 ft. above the river.

Anything from the pen of Mr. Forney, the author of the "Catechism of the Locomotive," is full of interest. Speaking of the balanced slide valve, he recently said: "It seems as though the balanced valve was one of the greatest improvements made in locomotives. It is one of those curious cases in which all the advantages are advantages, and there seem to be no drawbacks to them. In the first place, it increases the amount of effective work which a locomotive can do, because it lessens the amount of power consumed in moving the valve. In the next place, it lessens the amount of the wear of the valve on its seat. Next, it lessens the amount of the wear in the valve gear, and lastly, it lessens the amount of wear in the muscles of the engineer, which is a matter of some importance, perhaps. So that, altogether, in view of the fact that the size of the valves is gradually being increased, and the pressure of steam is gradually being increased, it seems that it would be almost impossible to run locomotives at the present time without balanced valves."

ELECTRICAL NOTES.

The Electric Railway Gazette contains a description of a chain feeder tramway. A chain is placed in a trough which is covered by sectional rails, which ordinarily are not in contact with the chain. When the car passes over the rail, a magnet on the car draws the chain into contact with that particular section of the rail. The chain, being connected with the feeders, makes that section alive while the car is passing over it. The sections are eight feet long, and the rail is made of a nonmagnetic metal.

Another strange freak of the electric current occurred on the Metropolitan Elevated Railroad, in Chicago, on the night of January 22. The current is delivered to the cars through a third rail. A sleety rain caused a coating of ice to form over the rail and the ties, by which the current was grounded and the whole system came to a standstill until the ice could be cleared from the line, which took several hours. As drops of rain fell upon the electrified ice, sparks were given out, and at times the whole line glowed as if it were ablaze.

In a paper before the Berlin Physical Society, Prof. Neeson recently gave an account of the destruction of four tanks of petroleum, each of which was protected by five-pointed conductors adequately put to earth. Two of the tanks were burned out and the other two were completely wrecked by a violent explosion. Prof. Neeson considers that the petroleum vapors above the tanks were ignited by small sparks during the discharge. This view he had verified by experiment. As a protection against lightning he advised that all openings should be protected by wire netting.

A large electric furnace, devised by Herr Urbanitzky for the reduction of iron ores, is described and illustrated in the Zeitschrift fur Electrochemie. He points out that an electric furnace is particularly advantageous for the reduction of very pure iron, but that heretofore furnaces large enough for the action to be continuous and on a large scale had not been built. In this instance, the large carbons enter the furnace from the top and are supported from a disk that can be revolved around a vertical axis. Five hundred horse power produce about 220 pounds of pure iron in twenty-four hours, requiring only one man.

Many instances have been noted in Germany of lightning flashes which, instead of being attracted by the lightning conductor of blast furnaces, take the charge of the furnace instead, passing through the ore and molten iron to the earth without doing any damage This phenomenon has occurred several times at one furnace where the conductor extends above the top of the furnace. The explanation suggested is that there being a column of smoke containing considerable aqueous vapor and carbon dust held in suspension, that this furnishes a better conductor of electricity to and through the charge than was afforded by the outside conductor itself.

A recent number of L'Electrician contains a contribution from Albert Nodon describing his experiments on the electrical charge of storm clouds. He made use of an electrometer, which consisted of an insulated metallic disk upon a Mascart base, which latter was placed upon a slab of paraffine. The disk was connected to a Mascart electrometer by a fine copper wire, which was carefully insulated. M. Nodon placed the disk in the open air during a thunder storm, and noticed that the apparatus accurately foretold the "precise moment of the coming discharge. At the instant when the maximum potential was reached—which was always the same—the discharge occurred."

Telephones in Russia.—It appears from statistics gathered by the Handels-Museum that the number of state telephone systems in Russia in 1894 was 34, the number of subscribers 3,938, the length of line 2,582 versts (1,712 miles), the length of wires 10,125 versts (6,713 miles), and the number of apparatus 4,397. As compared with 1893, the number of subscribers shows an increase of 32½ per cent., the length of line about 40 per cent., and the length of wire about 38 per cent. In 1894, 145,897 messages were exchanged on the state telephone lines. The number of telephone systems worked by private undertakings was the same in 1894 as in 1893, as the government no longer grants to private undertakings concessions for the establishment of urban telephone systems. The subscribers to private telephones numbered 8,004 in 1894, and the length of line was 1,152 versts (764 miles). In 1894 permission was granted for the establishment of 160 private telephone connections. The telephone is also used considerably by the railways. During the year under review there were altogether in general use 45 telephone systems; the number of subscribers was 11,825, and the length of line was 3,735 versts (2,476 miles).

The following are some of the results obtained with cast-welded rail joints, as stated in the Street Railway Journal: The 9,000 joints on the system of the West Chicago Street Railroad Company are reported by the chief engineer to have "complied with all requirements and proved very satisfactory." On the West Chicago and Chicago City system, out of 20,600 cast-welded joints put in last year, only 254 have broken. These were all broken in the first cold snap in November, and the breakage seems to have cleared out all imperfect joints and weak spots in the track, as since that time there have been practically no breaks, although the temperature variation has ranged from 8 degrees below zero to 50 degrees above zero. C. G. Goodrich, vice-president of the Twin City Rapid Transit Company, of Minneapolis, reports that he is much pleased with the way in which the joints have stood the cold weather and temperatures, which have gone as low as 24 degrees below zero. Out of some 2,000 joints put down on this road, only eleven have "drawn," and upon investigation it has been proved that in each case where a joint pulled apart, it was because of a poor weld, and the casting has been found full of blowholes. Equally good reports come from St. Louis, where it is proposed to cast-weld a large amount of track when the spring opens. It begins to look as though in cast-welding would be found the solution of the vexed rail joint question on our main trunk lines.

MISCELLANEOUS NOTES.

Lumbermen at Richmond, Me., have been troubled with an ice and log jam which is of mammoth proportions. It was seven miles long, and was estimated to contain 16,000,000 logs. The ice piled up to a height of 15 feet for many miles up the stream.

The report of the special inspector of the United States Department of Agriculture states that the increase of mechanical traction on street railways has thrown out of active service 300,000 horses, and a yet larger number will be displaced as time goes on. To feed that number of horses on the accepted average of 12 quarts of corn and oats daily would require 112,500 bushels, or in round numbers, 41,000,000 bushels annually. This is enough to materially affect the price of this grain, and to cause the railroads an enormous loss of tonnage—not less than 60,000 carloads.

The Forestry Division of the United States Department of Agriculture has stated in a recent bulletin that in the whole United States there are 2,000 miles of trestle structure, representing an expenditure of $60,000,000. This trestle work has to be replaced every nine years, on an average, causing an annual expenditure of $7,000,000. This capitalized at 4 per cent. involves a capital of $175,000,000 necessary to maintain these structures. For the purpose 260,000,000 feet, board measure, of timber is annually consumed, nearly all of which is cut from fine, large trees.

The economy of mechanical traction is established by the experience of the Metropolitan Traction Company, of New York City. It is stated that under the horse system operating expenses were 70 per cent. of the gross receipts, while after substitution of mechanical traction—cable and underground electricity—on 20 of the 120 miles under the company's control, they amounted to but 54·4 per cent. On the Broadway line alone operating expenses have been reduced from 66 to 38 per cent. Recent additions to the system make its mileage of single track cable 25·34, electric conduit 6·78 and horses 131·38.

According to Dr. G. Schatt, who has been making a special study of ocean waves, their speed in a moderate breeze is 16·8 miles per hour. Their size and speed increase proportionately to the velocity of the wind. In a strong breeze they increase to 260 feet in length, and reach a speed of 36 feet per second. In heavy storms their length increases to 400 feet and the speed to 28 miles an hour. Dr. Schatt does not think that the maximum height of the waves is very great; his maximum is just 32 feet. He believes that in great tempests waves of more than 60 feet are rare, and that even those of 50 feet are exceptional. In the ordinary trade winds the height is five or six feet.

The report of Capt. Macmillan, of the ship Dunhope, contradicts the commonly accepted theory that the approach of an iceberg at sea is always announced by a fall in the temperature of the surface water. He says: "Careful thermometric observations of air and water were regularly taken, but our approach to ice, always from windward, was not once indicated by any appreciable change of temperature in either air or water. On passing to leeward of the bergs a fall of a few degrees was generally observed in the air. On one occasion we passed within a cable's length of a berg and found the temperature to be the same there as at several miles' distance. This would go to show that in thick weather—or in any other—even temperature and thermometer at normal height should not be accepted as a trustworthy guarantee of immunity from ice."

The Suez and the "Soo" Canals Compared.—The Suez Canal passed in 1895, says the Journal of Commerce (New York), 3,434 steamers, which is not quite 10 a day. The St. Mary's Canal, open last year 231 days, passed 12,495 steamers, 4,790 sail vessels and 671 unregistered craft. The average number of vessels that passed through the canal on each day that it was open was over 72, and the average lockages per day was a fraction over 30. The 16,793 vessels of every class that passed through the "Soo" Canal last year had a registered net tonnage of 16,089,778, which is an average of not much less than 1,000 tons, and the freight carried amounted to 14,471,648 net tons. The number of vessels that passed through the Suez Canal in 1894 was only 82 less than the number in 1895, and the net tonnage was 8,039,105. The tonnage in 1895, then, very slightly exceeded one-half the tonnage of the "Soo" Canal, carrying almost entirely coarse bulk freights, and open less than eight months. Two and a half million tons of coal, nearly nine million barrels of flour, over forty-one million bushels of wheat and other grains, nearly eight million tons of iron ore, and three-quarters of a million thousand feet of lumber, board measure, were the larger items of freight.

Extracting Gold from Pyrites.—According to the Temps, a discovery which is likely to be of great importance to gold mining has been made by a French chemist, M. de Rigaud, who, it is asserted, has found a cheap means of extracting nearly the whole of the gold contained in pyrites. The process, which is claimed to be a considerable improvement on the cyanide process, consists in subjecting the ore after crushing to the action of a powerful solvent compound of chemicals of a comparatively inexpensive nature. It is stated that if heat be applied during the process the gold becomes separated from the ore in a few hours, but in practice it has been found that the same result is arrived at in about two days by simply leaving the solvent to do its work unaided. M. Rigaud estimates that a mill capable of treating 500 tons of ore a day by his process could be built at a cost of $100,000. The apparatus necessary for the manufacture of the solvent could be erected for about $1,250, and the substance itself would cost about $300 a ton. As a ton of the solvent would suffice to treat 5,000 tons of ore, the cost of treatment would only be about six cents a ton, exclusive of capital charges. The system of crushing would, of course, remain as at present. It is not claimed for the process that it can be applied to every class of ore, but it is believed that it will be found available in the majority of cases, especially for the treatment of parings and residue. It remains to be seen whether practical experience will confirm the results of experiments in the laboratory. The details of the process are wanting.

[Continued from SUPPLEMENT, No. 1057, page 16899.]

MECHANICAL ROAD CARRIAGES.

By W. WORBY BEAUMONT, M.Inst.C.E.

[Cantor Lectures before the Society of Arts.*]

LECTURE III.—Continued.

THE carriages built by Messrs. Peugeot Freres are of several forms, and all are driven like those driven by Messrs. Panhard & Levassor, by Daimler motors—generally, however, placed at the rear instead of the front of the vehicle. The vehicle is similar to that purchased by Sir David Salomon. This change in the position of the engine makes no material difference in the mechanism of transmission. The differential motion with its connected gear is utilized as a means of reversing the direction of motion of the carriage, which weighs about 16 cwt., and carries four persons.

This carriage took the first prize, as, although it came in second from Bordeaux, it conformed to a condition expressing preference for a carriage carrying four persons. In the trials organized by the Petit Journal last year the prize of £200 was divided by Messrs. Panhard & Levassor and Messrs. Peugeot; and five other chief prizes were won by carriages fitted with Daimler motors. The exception was the fifth prize, won by M. Roger, with a vehicle fitted with a Benz motor.

The actual amount of the prizes distributed to the winners in the Paris-Bordeaux race was 60,000 francs, divided as follows:

	Francs.
First prize, Peugeot Freres	31,500
Second prize, Panhard & Levassor	12,600
Third prize, Peugeot Freres	6,300
Fourth prize, Peugeot Freres	3,150
Fifth prize, M. Roger	3,150
Sixth prize, Panhard & Levassor	3,150
Seventh prize, Panhard & Levassor	3,150

Besides these, two special awards of 1,500 francs each were made to another petroleum vehicle of M. Roger, and to the steam omnibus Bolleé, both of these vehicles having accomplished the distance in less than 100 hours. A reserve of 3,951 francs was held for a future competition of the same kind.

In the trials in July, 1894, the second prize was awarded to Messrs. De Dion Bouton & Company for what may be called a steam horse or steam bogie. This vehicle † was exhibited at Tunbride Wells last autumn, in the exhibition organized by Sir David Salomons, when it worked very well, forming the motor of a landau. The Comte de Dion has done a very great deal in encouraging the design of motor carriages; and the French people credit him with taking the lead toward the success which they are now able to proclaim with carriages of various kinds.

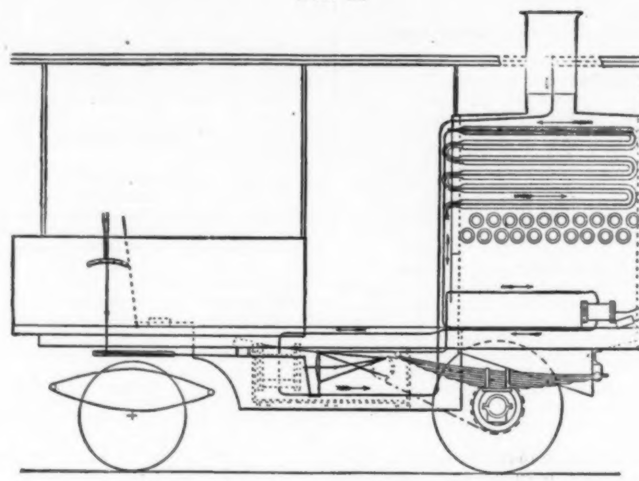
The light traction vehicle referred to was fitted at the rear with a center pin or locking pin, and cross springs to receive the front part or steering lock of an ordinary carriage from which the two front wheels were removed. A compound six-wheeled vehicle is thus made up of the motor vehicle and carriage. The boiler is placed in front of the motor vehicle and is of vertical form, in two main parts. It is made up of a central annular water chamber, the interior of which is the receptacle for the coke used as fuel, and is covered by a lid. This central part is surrounded by an annular chamber, to which it is connected by a large number of radiating short water and steam tubes. A diaphragm is placed in the annular chamber to cause the steam to pass by the upper radiating tubes in the annular chamber uptake, so that it may be dried. To further insure the drying, or, rather, the superheating of the steam, it is caused to pass through a coil, which is embedded in cast iron, and constitutes a ring, not shown, surrounding the grate. The shell tubes are at their ends let into annular grooves formed in the rings shown, through which bolts are passed to hold them together and make a steamtight joint. The products of combustion pass upward, among the radial tubes, to the annular space, and thence out at the top and down the flue. The heating surface of the boiler is 22·92 square feet; grate surface, 2·03 square feet; weight empty, 530 lb.; and it evaporates from 6 to 7 lb. per lb. of coke. The compound engine used has two cylinders 4·72 and 7·08 in diameter, with a stroke of 5·11 inches. Steam is cut off at eight-tenths of the stroke of the high pressure cylinder, and this, at 330 revolutions per minute, is said to give 18 horse power, which would take the motor weighing two tons and a loaded vehicle weighing 1·113 tons up a gradient of 1 in 12·5 at 12 miles per hour. The two cylinders were mounted on a cast iron frame,‡ which carried two bearings for the crank shaft, with a driving pinion upon it between the bearings. The pinion geared into a wheel on a short shaft carried between two bearings, the ends of the short shaft forming parts of universal joints, the other parts of these joints being formed on the jointed driving axle. The wheel on this short shaft contained within its run a differential motion. The driving wheels ran on large, short, hollow axles, or sleeves, attached to the springs, and sliding vertically through the range of the springs on a bent axle. The ends of the jointed driving axle pass the short sleeve axles (on which the wheels run), and at their outer ends carry a boss with four arms, which transmit the driving force to the fellies of the wood driving wheels, and thus free the spokes of all driving stress. The exhaust steam passed away with the products of combustion below the motor vehicle.

As I have said, this motor vehicle was shown at Tunbridge Wells, and received a prize in 1894, but it will be seen that it is a heavy vehicle, and is provided with more power than is necessary for the required speeds or the required weights. It has no second speed gear, and so must have great power to get up hills, which is unnecessary for ordinary running. The discharge of the steam is objectionable.

The third prize in the 1894 Paris trials was awarded to Mr. Morris Le Blant for his steam motor vehicle, having a carriage seating nine persons, and supplied with steam by a Serpollet boiler. In type it is the same as that of De Dion and Bouton. The jury considered this vehicle and its machinery specially suited for such as omnibus work. A vehicle by Mr. Le Blant is shown by Figs. 40 and 41. The boiler has no less than about 107 square feet of heating surface. The vertical section (Fig. 40) shows the position of the Serpollet boiler and of the double cylinder engine; cylinder, 6·69 in. diameter and 7 in. stroke. It makes 185 revolutions per minute and weighs 8·85 cwt. The boiler weighs 25·5 cwt. The total weight of this tracteur is nearly 4 tons, and is capable of hauling a load of 25 or 30 passengers in an omnibus or wagon, with maximum load of 5¾ tons.

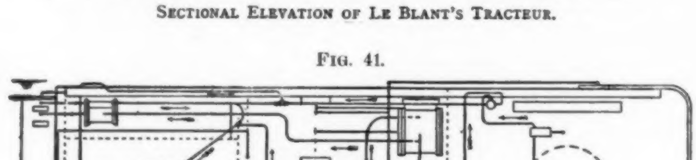
In the engravings (Figs. 40 and 41) A is the channel iron frame; C, C′, cylinders; G, boiler; D, differential gear, forming also the chain driving wheel; H, link motion lever; P, feed pump; p, chain pinion; m, coupling; R, tank; R, internal geared steering ring, with pinion, F, on vertical spindle; I, steam winch for discharging the contents of a loaded van; and J, a second feed pump.

FIG. 40.



SECTIONAL ELEVATION OF LE BLANT'S TRACTEUR.

FIG. 41.

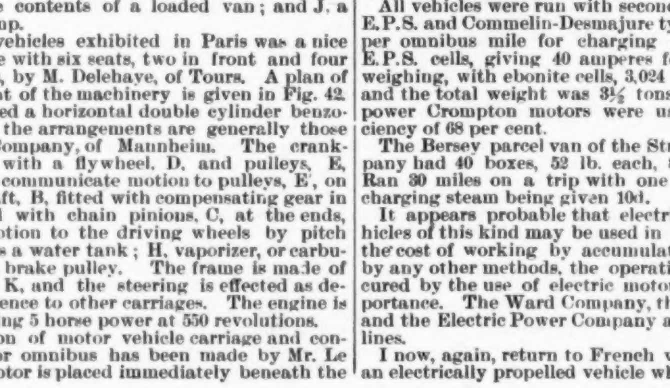


PLAN OF LE BLANT'S TRACTEUR.

Among the vehicles exhibited in Paris was a nice looking carriage with six seats, two in front and four wagonette seats, by M. Delehaye, of Tours. A plan of the arrangement of the machinery is given in Fig. 42. M. Delehaye used a horizontal double cylinder benzoline motor, and the arrangements are generally those of the Benz Company, of Mannheim. The crankshaft is fitted with a flywheel, D, and pulleys, E, which, by belt, communicate motion to pulleys, E′, on a transverse shaft, B, fitted with compensating gear in the center, and with chain pinions, C, at the ends, transmitting motion to the driving wheels by pitch chains. At J is a water tank; H, vaporizer, or carburetor; and G, a brake pulley. The frame is made of steel tubes, K K, and the steering is effected as described by reference to other carriages. The engine is described as being 5 horse power at 550 revolutions.

A combination of motor vehicle carriage and connected brake or omnibus has been made by Mr. Le Pape.* The motor is placed immediately beneath the front seat of the traction part of the vehicle, and its crank shaft carries a flywheel disk which, it is intended, shall operate a transverse shaft provided with differential gear and with a roller which, by frictional contact with the flat disk, is to give motion to the chain pinions by which the road wheels are driven.

FIG. 42.



DELEHAYE'S CARRIAGE (PLAN).

I do not know whether this vehicle has done any work, but the disk and roller form of driving gear described, although very well worked out for its kind, is not such as would, from former experience, promise much success. The motor is provided with two cylinders, weighs 110 lb. per horse power, and is of 6 horse power at 400 turns per minute. It is of M. Le Pape's design, employs benzoline and electric ignition. I mention it as containing a method of driving not used in other of the recent carriages.

Between the years 1886 and 1894 a great many attempts have been made to produce a satisfactory electrically propelled vehicle for omnibus or parcels carriage purposes. An electrically propelled cab was made in 1886 by Mr. Radcliffe Ward, and its gearing comprised an arrangement for obtaining either of two speeds.

In 1888 an omnibus, built by Mr. C. H. Yeaman, M.I.E.E., manager of the Ward Company, was run about 500 miles about the streets of London, under license. An improved omnibus and a parcel van were also built by the Ward Company.

All vehicles were run with secondary batteries of the E.P.S. and Commelin-Desmajure types, said to cost 3d. per omnibus mile for charging current. Fifty-six E.P.S. cells, giving 40 amperes for three hours and weighing, with ebonite cells, 3,024 lb., were employed and the total weight was 3½ tons. Two 2½ horse power Crompton motors were used, having an efficiency of 68 per cent.

The Bersey parcel van of the Street Carriage Company had 40 boxes, 52 lb. each, 80 volts 40 amperes. Ran 30 miles on a trip with one charge, the cost of charging steam being given 10d.

It appears probable that electrically propelled vehicles of this kind may be used in towns, as although the cost of working by accumulators is greater than by any other methods, the operating advantages secured by the use of electric motors are of much importance. The Ward Company, the Clubbe Company and the Electric Power Company are working on these lines.

I now, again, return to French vehicles to describe an electrically propelled vehicle which was made and ran in the Paris-Bordeaux trials of the Petit Journal, namely, that of M. Jeanteaud. It is true that the benzoline motor propelled vehicles ran away from it, but arrangements were well made for it, and it made a good fight.

The batteries used for the Paris to Bordeaux run were of the Fulmen make, weighed 850 kilogrammes complete (between 16 cwt. and 17 cwt.), and were made up of 38 cells, contained in 12 boxes of three or four cells each. The electrodes of each cell weigh 33 lb., and have a capacity of 300 ampere hours under the ordinary conditions of a discharge spread over 10 hours. At the rate of discharge of 70 amperes, or 2·1 amperes per pound of plate, the capacity of the bat-

* From the Journal of the Society of Arts.

† The Engineer, July 20, 1894.

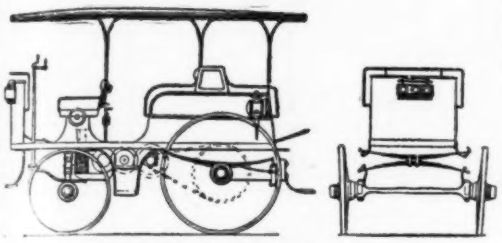
‡ "La Locomotion Automobile," February, 1896.

* "La Locomotion Automobile," November, 1895.

tery was still 210 ampere hours. Unfortunately, the adoption of 10 hours as the time of discharge would place a very low limit on the rate of speed. The best speed record for electric carriages belongs at present to Mr. Jeanteaud.

The carriage (Fig. 43) has two cross seats, each holding two persons, and a third seat at the back, also for two persons. There is a dashboard in front carrying an electric lamp. The accumulators are placed under

FIG. 43.



JEANTAUD'S ELECTRICAL CARRIAGE.

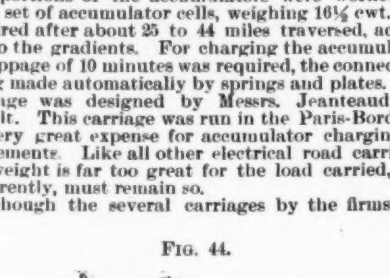
the hind seats. The wheels are hickory, and are respectively 39½ in. and 55 in. in diameter. The total weight of the loaded carriage is about 3 tons 3 cwt., and this is distributed so that the front wheels support 23½ cwt. and the rear wheels 39½ cwt. Each of the front wheels is independently pivoted for steering purposes on the Ackerman system, already described with reference to several vehicles. A brake acting on the naves is used, and an auxiliary brake worked from either side of the front seat. The wheels are driven by two chains, from a spindle carrying the differential speed gear, giving speeds of 7 or 15 miles per hour. The change of speed was to have been done by a Bovet magnetic gear, but this not being ready in time, ordinary spur gear was substituted.

The motor was constructed by the Société Postal Vinay, and has an efficiency exceeding 90 per cent., and at its normal rate is intended to give 7 horse power at 70 volts. The weight of the motor is about 4½ cwt., and it can be made to develop 14 horse power or 15 horse power when mounting inclines.*

For the Paris-Bordeaux run it was arranged that only the steering should be done by the conductor, the driving apparatus being managed from the second seat. This includes reversing gear and switches for the accumulators, and for separately exciting the field magnets, so as to maintain the same speed down hill as on the level. This was found exceedingly useful, the motor acting as a brake, and under certain circumstances delivering back a current of 80 amperes to the accumulators. Practically, however, the amount of the current so restored was not worth taking into account, but the regulation of the speed down hill was, it is said, perfect. On the other hand, at slow speeds only portions of the accumulators were worked. A fresh set of accumulator cells, weighing 16½ cwt., was required after about 25 to 44 miles traversed, according to the gradients. For charging the accumulators a stoppage of 10 minutes was required, the connections being made automatically by springs and plates. The carriage was designed by Messrs. Jeanteaud and Brault. This carriage was run in the Paris-Bordeaux at very great expense for accumulator charging arrangements. Like all other electrical road carriages, the weight is far too great for the load carried, and, apparently, must remain so.

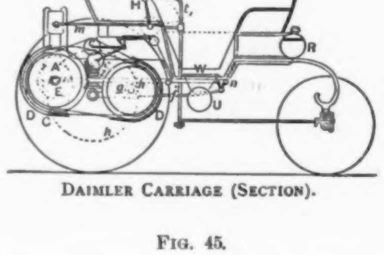
Although the several carriages by the firms who

FIG. 44.



DAIMLER CARRIAGE (SECTION).

FIG. 45.

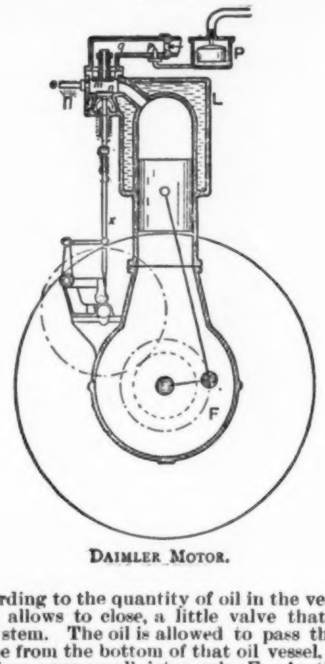


DAIMLER CARRIAGE (PLAN).

used the Daimler motor achieved so much success, the Daimler Company in London have made some modifications in the design, not only of this celebrated motor, but in the arrangement of the gear by which it transmits the motion to the driving wheels. A section showing the general arrangement is given by Fig. 44 and a plan by Fig. 45, from which it will be seen that the power is imparted to the transverse shaft by means of belts which run over tightening pulleys, C, by the use of which either of the speeds due to the two different sizes of pulleys may be used. The water tank which contains the cooling water is supplemented by a second part, at W, which acts at the same time for foot warmer in winter, and a new method of continuous water cooling under Maybach's patent is adopted. This latter consists in directing the heated water into the annular channel of a wheel similar to the water channel wheel used for friction brake dynamometers,* in which the warm water is whirled at the speed of the engine fly wheel, and is taken back continuously by a tubular offtake, such as that used in milk separators. The whirling and the evaporation together effect a good deal of cooling of the jacket water.

Some improvements made in the engine are shown by the next illustration. The carbureter is modified, so that no air regulation valve is required. It will be seen that there is a slight difference between this motor and the motors that have been used hitherto. The supply of benzoline is placed in the small vessel, marked P (Fig. 46), and in it is a float, which rises and

FIG. 46.



DAIMLER MOTOR.

falls according to the quantity of oil in the vessel, and opens, or allows to close, a little valve that is seen above its stem. The oil is allowed to pass through a small tube from the bottom of that oil vessel, and the top of it is a very small jet nozzle, F. As the air is drawn in by the descent of the piston it enters where the arrow is shown near F, and in passing over the top of the jet, F, induces a current of oil, and at the same time breaks it up into a very fine spray, which passes with the air into the cylinder. In this way the oil becomes converted into gas, and is easily ignited by the heated ignition tube. The governing is effected by the exhaust valve. When the engine has sufficient oil the governor holds the rod, X, up so that the exhaust valve, N (under the admission valve, M), by means of the finger at the lower end of the rod, and this valve being open, no air is drawn in past F.

(To be continued.)

* The Electrical Engineer, October 18, 1895.

* Proc. Inst. C. E., vol. xcv, pp. 13-15. The Engineer, December 20, 1895.

MOTOR VEHICLE TESTS.

THE ENGINEERS SUBMIT THEIR REPORT OF THE TESTS MADE AT CHICAGO—VALUABLE DATA FOR MAKERS AND USERS ALIKE.

JOHN LUNDIE and Leland L. Summers, the engineers appointed to conduct the tests of motor vehicles made at Chicago previous to the race of November 28, have submitted their report, which we reprint from the Chicago Times-Herald as follows:

In selecting a method of testing the vehicles submitted, an effort was made to adopt a system which would enable a comparison to be made directly with the methods of propulsion at present in use. To some extent this involved the economic aspects as well as the engineering features of the question, so that it has been deemed proper to briefly consider some of these.

The question of practicability, or whether the self-propelled vehicles can accomplish the results obtained by vehicles as ordinarily propelled, is perhaps the question of first importance, and in considering comparatively the results, naturally the horse would be selected as a basis of comparison. To enable this comparison to be made without involving the subject in undue technicalities, a brief digression, dealing with the early investigations of the power of the horse, may not be irrelevant, particularly as the horse has long been a source of motive power, and for this reason was early selected as a comprehensive unit of comparison.

HORSE POWER THE UNIT.

With the advent of the steam engine it was found necessary to compare the rate at which the engine could do work with the rate at which a horse could do work, in order that the purchaser of an engine could specify the power required in a unit he was familiar with. As the power the average horse was capable of exerting had been but indefinitely determined, experiments were made by James Watt to obtain definite figures, and for this purpose a weight of 150 pounds was arranged to be raised by the horse, when it was found that the weight could be raised at the rate of two and one-half miles per hour, or 220 feet per minute. Multiplying the weight in pounds by the feet traveled per minute, Watt obtained 150 × 220 = 33,000 foot pounds per minute as the power which the horse could exert. This power could be exerted for eight hours per day, but for a fewer number of hours per day a higher rate of doing the work could be developed. Numerous experiments made since those of Watt have indicated that Watt's measurements were upon horses far above the average; the best authorities agreeing that the power of an average horse should be considered about 22,000 foot pounds per minute. Upon this basis a table (Trautwine's pocket book) of the pull a horse could exert and the corresponding speed in miles per hour would be as follows:

Miles per hour.	Pull or traction.	Miles per hour.	Pull or traction.
Three-fourths	333·3	Two and one-fourth	111·1
One	250	Two and one-half	100
One and one-fourth	200	Two and three-fourths	90·9
One and one-half	166·6	Three	83·3
One and three-fourths	142·8	Three and one-half	71·4
Two	125	Four	62·5

It is evident that not only can the horse exert a heavy pull at a low speed, but that it is capable of exerting a wide range of pull, which makes it particularly suitable for the purpose of hauling vehicles. Experiments differ as to the maximum pull the horse can exert, and the conditions of footing, character of load, etc., greatly affect the results. For the purpose of determining roughly a probable value, an express horse of average type was tested by your committee, and, without resorting to violent methods of persuasion, the maximum pull obtainable was found to be about 250 pounds. It is probable that 400 pounds is about the maximum with a good horse. On the other hand, when the pull is light a considerable range of speed may be obtained, and a measure of the power exerted by the horse at all times may be obtained by multiplying the pounds pull by the speed in feet per minute. Dividing this by 33,000 gives the ordinary unit known as the horse power. The figure of 33,000 foot pounds per minute obtained by Watt is commonly adopted as the number of foot pounds per minute constituting a horse power.

The determinations actually made of the pull required of a horse in pulling a vehicle are not very numerous or authentic, as owing to the fact that the pull is apt to be irregular many difficulties are encountered in measuring it, and no great accuracy is attainable.

A comparison of the motocycle with the performance of a horse involved then a measurement of the pull the vehicle could exert, and a determination of the speed the pull was exerted at. A testing machine was accordingly designed with the primary object of measuring these factors. The power of the vehicle was readily obtained from these by multiplying the pounds pull by the feet per minute traveled. This being divided by 33,000 would then give the mechanical horse power exerted by the vehicle on the rim of the wheel at any instant.

As this power measurement of the vehicle would determine its ability to propel itself under different conditions, a measurement of the fuel consumed in accomplishing this would enable the item of cost to be obtained. The net results, therefore, sought were how much power would be available at the rim of the wheels for a given expenditure of money.

In the case of a gasoline engine a measurement of the gasoline consumed in a given time, while the motocycle was exerting a given power, would enable this cost to be determined directly. In the electrically propelled motocycle a measurement of the power consumed in producing a given power at the rim of the wheel would enable one to calculate the cost of propulsion when the cost of electrical power for charging the batteries was known. In addition to considering the cost of producing a given amount of power at the rim of the driving wheels, it was considered advisable to determine, if possible, the losses between the driving motor and the rim of the wheels. These determinations would show how efficiently the power generated by the motor was transmitted to the wheels of the vehicle. The various methods adopted of regulating and controlling the speed and power of the vehicle might also affect the consumption of fuel and result in a less amount of power being available for a given amount of money expended in fuel. Very accurate data is available concerning the usual types of motors, similar to those used for propelling vehicles. This data is confined almost entirely to their use for stationary purposes, however, and very little information is extant regarding their application to vehicles.

FUEL TESTS.

Under these circumstances somewhat extended tests were made to ascertain the consumption of fuel and performance of the vehicles under the various loads apt to be imposed in practice.

In order that the same conditions might exist for all gasoline vehicles under test they were all supplied with gasoline from the same barrel, the density of which was found to be 0·688.

No effort was made to obtain a particular density of gasoline, as it was deemed best to use that ordinarily to be obtained from the retail dealer. Cost of gasoline has been estimated at two cents per pound in deducing the results shown in the appended table.

The cost of electrical energy has been estimated at 10 cents per kilowatt hour. The storage batteries are assumed to have an efficiency of about 75 per cent., making a cost per horse power hour delivered to the motor of 10 cents.

MAXIMUM PULL OF VEHICLES.

In order to still further compare the performance of the motocycles with that of the horse, efforts were made to determine the maximum pull which the vehicle could exert as compared to that of the horse. It is evident this would only be of interest in determining the performance of the vehicle when operating under extremely unfavorable conditions, and in this connection it is only fair to add that the vehicles submitted were all designed for a light passenger service and not to exert a heavy pull, so that a medium pull exerted at a high average rate of speed was the object sought rather than a heavy pull under adverse conditions. For determining this feature the pull on the motocycle was increased until the limiting conditions were reached, with the results shown.

It is apparent that the heaviest pull exerted, viz., that with the Duryea vehicle, amounted to only 187 pounds, as compared to 400 pounds which a single horse could exert. It was not possible in any of the tests made to slip the driving wheels, so that the traction in all cases was ample, and if a greater driving power had been available by means of reducing gearing or otherwise, it would probably have been possible to obtain a correspondingly high result. In the case of the belt driven machines of the Benz type, the limit was usually reached when the belts slipped. Owing to the defective conditions of the belts on the Macy ma-

chine, which possessed one of the most powerful motors of any of the vehicles submitted, the maximum effort was not obtainable.

The Lewis motocycle was equipped with a special reduction gear enabling a very heavy pull to be produced. An effort to obtain this heavy pull from the vehicle resulted in the breaking of the driving chains. Under these conditions it is hardly fair to consider the results as the best obtainable. In the machines directly geared any attempt to obtain heavier pulls than those given resulted in stalling the motors. The pull obtained with the electrical vehicles is, of course, only limited by the heating effects of the excessive current required.

It will be observed that there is a wide difference in the consumption of gasoline by the various engines submitted. This is naturally to be expected when the types of engines are considered. In the case of the Lewis and the Haynes & Apperson vehicles the cycle is such as to give an explosion every revolution, the piston itself uncovering the exhaust port, this type of engine being variously known in stationary practice as the Single, Sintz or Day cycle. The exhaust from these engines was so densely laden with unconsumed carbon that an exhaust pipe and fume blast were required to convey the fumes from the testing room. This simply bears out the well known fact that this type of engine, giving an explosion for every revolution, while possessing many advantages, has a very low economy due to the improper combustion of the fuel supplied. The other motors presented were almost all operated upon the Otto cycle. In the Benz type of motor the gasoline was thoroughly carbureted before being admitted to the cylinder, while in the Duryea and others the gasoline was vaporized directly at the cylinder. The results obtained therefore enabled a partial comparison to be made between these methods of utilizing the gasoline.

It is to be regretted that, owing to a derangement of the igniting mechanism in the Duryea engine, higher power tests were not possible with this vehicle.

It is a well known fact in gas engine operation that the economy of the engine at light loads is, if anything, inferior to the steam engine under similar conditions. In the application of the gas engine to a motocycle the economy is particularly low for the reason that a considerable proportion of the power is sacrificed in driving the mechanism. Owing to this feature the consumption of gasoline per horse power hour at the rim of the wheel is quite large when the motocycle is operated under an ordinary load. Thus with a load requiring about three quarters of a horse power for its propulsion, it is evident that as high as one and one-half horse power may be required in the engine in order to overcome the friction of the mechanism. If the motor is designed to give three or four horse power at the rim of the wheels, the motor is lightly loaded under the ordinary conditions, and the economy as a result is very low.

In this connection the Benz type of vehicle presents another interesting feature of comparison. These vehicles are provided with but two ranges of speed when the gas engine is running at its normal speed, and in order to increase the range of control the supply and proportion of the mixture of air and gasoline is varied. This is accomplished by a regulating valve controlled from the driver's seat. The explosive force of the mixture is readily controlled in this way, and a wide range of speed is thus given to the vehicle without the necessity for complicated mechanical devices for speed regulation. This simplicity and ease of control may, however, be purchased at the expense of economy, as will be apparent from the tests of various loads.

It is evident that under the best condition of load a horse power can be produced at the rim of the wheel with almost one-fourth the rate of consumption of gasoline that it can under the worst conditions. With a type of vehicle such as the Duryea, where the speed of the gas engine is maintained constant, and the speed regulation is affected by changeable gearing, the economy with variable speed of the vehicle is dependent entirely upon the load carried by the engine. Under some conditions, therefore, it is possible for a motocycle to ascend grades at the same speed as upon a level road and with the same consumption of gasoline. In other words, the loading of the engine may so increase the efficiency that it will enable it to give the increased power without increase in the consumption of gasoline. As far as possible it was endeavored to ascertain if the jolting of the vehicles using a carbureter would affect its action; in other words, if the explosive character of the mixture was varied by the effects of the vibration of the vehicle. So far as could be determined, no effect was noticed in this respect: the carbureter apparently at all times supplying an even mixture.

The location of the driving engine and the method of transmitting the power to the driving mechanism greatly influences the amount of vibration there is to the vehicle. In the Benz type of vehicle the single cylinder engine, giving an explosion at every second revolution, is mounted with the cylinder at right angles to the axle of the driving wheels. The effect is to cause considerable vibration, and unless special means are adopted for counteracting this, it is transmitted to the body of the vehicle, resulting in more or less discomfort to passengers at the time of starting, although afterward it is not so noticeable. In the Duryea vehicle the two driving cylinders are parallel to the axle of the driving wheels, and any reactive effect from the cylinders produces a vibration transversely. The vehicle of Messrs. Haynes & Apperson is provided with two cylinders, one on each side of the crank shaft, and the reactive effect is greatly diminished.

From the consideration of these questions it would appear necessary to use more than one cylinder to eliminate vibrations, and preferably these cylinders should be arranged upon opposite sides of the driving shaft in order that the reactive effect may be entirely balanced and the vehicle freed from vibratory effects when the engine is running, though not propelling the vehicle.

ELECTRIC VEHICLES.

In considering the electric vehicles it is evident that in using a variable current from the storage batteries, as the discharge rate is increased beyond the normal, both the life and efficiency of the battery will be diminished. In the Morris-Salom vehicle the batteries were rated at 50 ampere hours, with a discharge rate of 5 amperes. When discharging at a rate of 22 amperes it is evident that the available capacity of the cells will be greatly diminished. It is perhaps unfair to assume, therefore, that the efficiency will remain constant. While the mechanical efficiency is higher with a heavy load, the electrical efficiency as a whole may be diminished. The correction necessary for these factors will depend so largely upon particular conditions that no allowance has been made for them. The assumption of 75 per cent. efficiency in the batteries will be a fair average for normal conditions. The cost of electrical energy will also vary with the conditions, so that both of these factors must be considered in estimating the cost of operation. The heavy depreciation of the batteries when subjected to excessive discharges will also constitute a charge against cost of operation.

SINGLE AND DOUBLE MOTORS.

An interesting comparison may be made between the Sturges vehicle and that of Messrs. Morris & Salom. Both of these vehicles are equipped with the same type of motor, the Sturges vehicle being propelled by a single motor of three horse power, while that of Messrs. Morris & Salom is propelled by two one and one-half horse power motors. A single axle with the wheels solidly mounted, the carriage being carried by the journals on this shaft after the pattern of a car journal, is the method of driving adopted in the Sturges vehicle, while in the Morris & Salom the pinion on the motor is geared directly to the driving wheels, the wheels being provided with ball bearings, and every effort being made to diminish friction.

The tests indicate that with the best workmanship possible the two motors have but slightly higher efficiency than the single motor, though the mounting of the single motor is in a measure crude. The electrical and gear losses with two motors would, of course, be greater than with a single motor. The advantages of the series parallel control of the motors when storage batteries are used, and may be grouped to regulate the voltage, does not, therefore, seem necessarily to be a factor of sufficient importance to warrant the adoption of two motors.

Apparently the only other factor to particularly commend this arrangement is the elimination of a differential gear for enabling the wheels to travel independently of each other when curves or corners are being turned. In driving with a single motor of any type it is evidently necessary to provide a means for driving the wheels independently of each other, as otherwise a binding action on curves would result. The method adopted in almost all the gasoline vehicles presented consisted of some form of differential gear, each driving wheel of the vehicle being separately connected by means of a sprocket chain to the same countershaft.

(To be continued.)

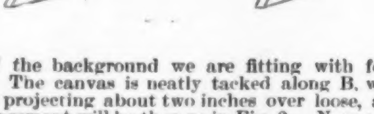
HOME MADE PHOTOGRAPHIC ACCESSORIES.

"NOTA BENE," in the Junior Photographer, says: A good accessory does not necessarily mean an object labored with highly finished modeling, necessitating a knowledge of renaissance ornament and design, but, on the contrary, the simplest and most everyday objects are those best suited to our purpose, and, generally speaking, giving the best results.

To save time we will at once commence, and one of the most useful things we can possess is a foreground to fit a background, and entirely hide the joining of the background and floor, producing continuity from the immediate foreground to the extreme distance.

The material selected may be stout paper or canvas. This should run the full width of the background, and if it be five feet wide, this will be found sufficient for all purposes. If canvas is the material selected for the foreground, the sheet must be stretched and sized just as for painting a background. With the exception of the flour paste size, jelly size diluted with water should be used; this size is obtainable at any house painter's; this will give a stiffer ground to work on. We will suppose it is an exterior ground to which we are fitting the foreground, and the bottom of the background may be weeds, plants, stones or any of the numerous foregrounds nature offers us, but whatever be the character of the lower portion of the background, our foreground must carry out the same idea, and when viewed from the camera must look part and portion of the background, no joining up or suggestion of joining being visible. The easiest way of producing this effect is by laying the sized canvas on the floor in front of the background and causing the edge nearest the background to be quarter rolled up, the top edge cut irregularly and the whole carefully tinted to match the background, detail being filled in carefully afterward. The arrangement for holding the canvas foreground in position is shown in Fig. 1, and explains itself.

A A, two triangular pieces of wood held together in position by a lath, B, the length of which equals the



width of the background we are fitting with foreground. The canvas is neatly tacked along B, with the edge projecting about two inches over loose, and the arrangement will be then as in Fig. 2. Now with colors prepared as directed in the article already referred to (but with a larger proportion of size added) tint the canvas all over, matching the tints with background, the actual figuring depending, of course, entirely on the background. The upper edge, C, having been cut very irregularly and all being quite dry, fill in details, bearing in mind all the time to keep standing back and noting the effect. The irregularities along edge, C, may be bent about with the fingers, and the edge trimmed in places with artificial creepers; with careful touching up and tint matching, the foreground will speedily merge into the background, and with ordinary care the joining, or edge, C, will be undiscernible. It will be noticed in Fig. 2 that the crest of foreground, C, is actually some inches in front of the background; this is immaterial, and the background can touch the foreground if required. Any interior background can be fitted with foreground just in the same manner by carrying forward and maintaining the individuality of the lower portion, matching the tints thoroughly before proceeding to lay in the foreground. Interiors having tiled and flagged floors and carpets with marked patterns are

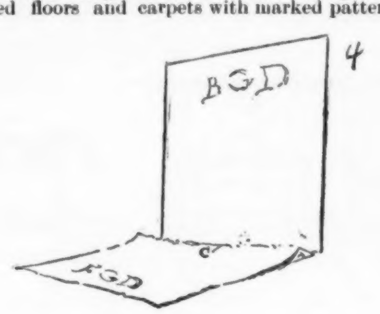


Fig. 2.

most easy to treat in this manner; bear in mind to repeatedly retire to observe the effect and insure as far as possible correct perspective.

We will now undertake a pair of rustic gate posts with an old gate in keeping. This makes a really first class accessory, and the construction once mastered—and it is extremely simple—will enable any one to make a very good accessory of any given subject. By referring to Fig. 3, the spectator will be found taking his view from a point opposite the center of the gate posts. This simplifies matters to a certain extent, as the posts and old wall on each side have the same outlines, only reversed, the position of the spectator being the same with regard to both sides. Begin by making a complete, careful outline of the right hand post and wall on a large sheet of paper, making the gate post about 3 feet 6 inches high and carefully noting the various proportions, which may be altered, of course, to suit the fancy of the maker. This being

Fig. 3.

done, lay aside and obtain some thin boarding of uniform thickness; this equality of thickness is most important. The widths won't much matter if the lengths be sufficient; these should be about 2 feet 6 inches long. The thickness of the boarding should be ¼ to ½ inch. Now lay on the floor enough pieces—side by side, edge to edge, close together—to make a rectangle about 3 feet 6 inches high, and having all the pieces the length suggested will give 2 feet 6 inches wide; now close all the joints as much as possible, and take care that the floor on which the boards are laid is perfectly level; secure all together by nailing across, at right angles to the direction of the boards, two stout battens, taking care that any nails coming through the points are hammered down flat. Next, carefully cut out the paper pattern round the outlines and lay it on the front of the boards and mark round the outlines with anything strong enough to give a good working line. With a thin fine saw, all the wood outside the outline is cut away, until we have one side of our set piece cut out in profile; now take some plaster of Paris and mix up in glue water, and with this—using it rather pasty—smear the face of the boards over, filling in all the nicks, etc. Keeping the paper outline by you, you will see the division of the post and rough wall; work the plaster and vary the textures, and when this has been done lay aside to dry; when dry complete the outline on the plaster and paint up to suit the subject, taking care to keep the lighting right. The gate is made up of strips and roughly plastered, attention being paid to the tinting, not making it too light. The left hand gate post is the same thing over again, only reversed.

Should any part of the accessory show the thickness of the material, this must be attended to, by beveling away from the front edge to the back. A sharp knife and a spoke shave will do this effectually.

A first rate foreground—and this is very easily made—is the "Cornfield foreground." All that is needed is some corn, long grass, and any nice artificial produce, as the ox eye daisy, etc. The foreground, however, may be made up of the natural material only and be no worse for it, but often better. Get a lath ¾ × 2 inches and the length equal to the width of the foreground; arrange the lath so that the 2 inch side is in a vertical plane, and an inch or so from the ground; this can be quickly done by applying triangular pieces at the ends, as shown in Fig. 1, with this difference, that the lath will rest in a piece cut out of each triangle below the vertice, and will be perpendicular to the

ground, whereas the lath, B, shown in Fig. 1, is inclined to the ground at an angle equal to side of the triangle it lies on. Now take the grass, etc., and cut the bottom ends clean, and supposing the material we are using to have been previously dried, lay along the lath the cut ends of the grass, etc., so that when the lath is supported in position by the triangular ends, the grasses, etc., grow upward from it. Now, having laid the grasses, etc., at right angles to and on the lath, and taking care that they are not too regular, or too thin in places, get some hot glue and run it along the lath over the ends of the grasses lying on it, and while this is wet lay over some wide tape and securely tack it along; this will effectively fix the grasses in position, and when they are dry they will always stand erect.

On the same principle bulrushes and creepers may be made into very fine foregrounds, and where any difficulty is experienced in keeping the materials from drooping or falling, nail to the triangular ends uprights of the required heights, and across at intervals, as desired, run fine wire; this will give you a good foundation, and the wire cannot be seen in the photograph.

THE UNITED STATES AND CUBAN BELLIGERENCY.

THERE is a fidelity about a "snap shot" photograph of a mob of people which renders it more graphic than the most skillfully drawn sketch or the most detailed description. A correspondent of Le Monde Illustré, who was present at the Barcelona demonstration against the United States consulate, succeeded in taking an excellent photograph of the surging multitude—which is herewith reproduced—just at the time when it was turning to leave the square. It will be remembered that the publication of the dispatches announcing the actio of Congress in moving to recognize Cuban belligerency aroused the Spanish people to a sudden outburst of anger, which, in some cities, expressed itself in threatening riots. In this display of feeling the Spanish people have shown a certain measure of inconsistency; for it is a matter of history that Spain was one of the first among the foreign powers to accord belligerent rights to the Southern Confederacy.

The sentiments of the Spanish government on the question of granting belligerent rights to the revolted subjects of a friendly power were thus expressed with distinct emphasis.

To-day the question is again before the two powers; but with the conditions reversed; and Congress is merely following a precedent already established by Spain in passing the present resolutions.

According to international law, the recognition by one power of the belligerent rights of the revolted people of another power as soon as they possess a government and revenues is not an unfriendly act. The step between such recognition and an armed intervention on their behalf, however, is a wide one. It was the threat of intervention in the concluding sentence of the resolutions, as originally drafted, that rendered them exasperating to the Spanish and obnoxious even to many of the best friends of the Cubans in this country. This threat has now been expunged; and the resolutions have thereby gained in dignity, and in the strength of the support afforded them.

The deep interest of the United States in Cuban affairs is nothing new, nor is it merely a passing incident in her history. In 1848 we find President Polk proposing to the Spanish government the transfer of the island to the United States for a stated sum; and ten years later a proposal to make the same purchase is again seriously debated in the Senate. In the Cathedral at Havana lie the bones of the great discoverer whose fame is built upon the fact that he was the first to open up the new to the old world and so make possible the development of the great Republic of the West.

It was inevitable that the descendants of the men who signed the Declaration of Independence should ever be quick to sympathize with any uprising of a people whom they believe to be struggling under the yoke of a foreign and discriminating taxation. But at the same time it is, or should be, a far step from sympathy with one party in a contest to deliberate menace or insult of the other. The granting of belligerent rights to a revolted people is in itself, in the very nature of it, a delicate proceeding. It calls for the exercise of sober judgment, well weighed words and the exercise of the highest diplomatic tact, both in the framing of the resolutions and in their subsequent debate. The etiquette of international intercourse is as binding upon a people as that of every-day social life is upon the individual. Indeed, in view of the tremendous issues at stake, it is more binding.

In drawing up, debating and passing the resolutions of belligerency there is everything to gain and nothing to lose by courtesy and moderation. International law on such questions is explicit, and the determination of the question as to whether Cuba has or has not fulfilled the conditions which are necessary to belligerent rights is a question of evidence pure and simple. It can never be determined, as some members of Congress appear to think, by wholesale abuse of Spain.

The resolutions as originally presented to both Houses of Congress were ill drawn, menacing, and intemperate, and it is no wonder that the Spanish, the proudest of all people, should have resented the whole tone of the resolutions, and the hostile and sometimes ignorant harangue that followed during debate. The whole was in keeping with the spirit of thoughtless intemperance and aggression which has generally characterized the action of the present Congress, and which has defeated generally its own ends by bringing discredit upon that body and raising a feeling of hatred that was avoidable and wanton, and which serves to unite the opponents of Cuban liberty, and make their course seem justifiable.

We believe that soberer thoughts now prevail, and that the amended resolutions will practically be confined to mere recognition of belligerency. All such matters of international concern pertain rather to the diplomatic and administrative departments of government than the legislative, and many regard with jealousy the intermeddling by Congress with matters which they believe could be better handled by the administration.

International law requires that before a revolted people are entitled to belligerent rights they must have a constitution, a central government, an organized army, and a source of revenue. As the question now stands, Spain is endeavoring to persuade the world that the insurgent bands are composed of the lowest elements of the mixed population, aided by a few outside adventurers; and that the native white population is faithful to the government.

On the other hand, the Cubans assert that they have taken special care to comply with all the requirements of belligerency; that they have declared a republic, whose constitution is based upon that of the United States; that they have a central government, whose seat is at the city of Cubertas in East Central Cuba; that their army is organized, and the strictest discipline maintained, and in evidence of this discipline they point to the success with which they have marched and countermarched, and outwitted the Spanish generals; and, lastly, they claim that the whole of those provinces which are under their control are subjected to regular taxation, and that their revenues from this source are increasing.

They claim, moreover, that the sons of the native Cuban whites are in the armies of Maceo and Gomez; and that the heads of families are loyal to Spain simply from fear of confiscation and imprisonment, whereas their sympathies are with the insurgent armies. They claim that the destruction of houses is undertaken to remove all shelter for Spanish riflemen, and that sugar plantations are destroyed in conformity to that accepted principle of war which aims to cripple the resources and revenue of the enemy.

The Spanish forces are at present concentrated in and around Havana. The insurgents are in three divisions. One is holding the western end of the island, under Maceo, who is reported to have been joined by Garcia and the expedition which recently sailed on the Bermuda, and to have captured the city of Pinar del Rio, the capital of the province.

The province of Havana is infested by wandering bands who keep up a scattered guerrilla warfare with the Spanish troops, and the campaign in the province of Santa Clara, to the east of Havana, is being carried out under General Gomez. Insurgent interests in the extreme east of Cuba are under the care of a brother of Maceo.

At the present writing, it looks as though Captain General Weyler has done but little effective work toward suppressing the rebellion. It was announced that he would personally lead his armies, and attempt to force the insurgent forces to a pitched battle. This he has failed to do; and, either from choice or necessity, his operations are confined to the province of Havana.

THE RECENT DEMONSTRATION AGAINST THE UNITED STATES CONSULATE, BARCELONA.

THE NEW INDUSTRIAL SOUTH.*

IT is but thirty years ago since two great American armies were locked in the grip of a bitter strife upon Southern battlefields. The courage, heroism, and resourcefulness of the combatants made it evident that, should they ever become united in a common cause, they could not be withstood.

The close of the war found the South in a pitiful plight; and it is a trite saying that the sublime patience displayed by the survivors, during the years which immediately followed the close of the war, finds few parallels in history. Patience alone, however, can never accomplish much; but, when the Southern people began to put their activity and courage, which they displayed so magnificently on the field of battle, into business, the development of resources, and the upbuilding of their land—then we saw how great things patience allied to activity could accomplish. For the first fifteen years following the close of the war, the South was engaged in slowly adjusting itself to the new social conditions; in fact, the history of that country during the past generation is capable of two natural divisions: the first the period of patience; the second the period of activity. During the first half of the time men were not, however, altogether idle. They were quietly prospecting the country, ascertaining what were its stores of mineral wealth and where they lay, and showing the various openings for future commercial enterprise. When the earlier years of waiting had passed, the South was fully prepared for the capital which had long been seeking admission, and the last ten or fifteen years have seen a development which is not only remarkable for its extent and the diversity of its results, but magical in its proportions.

I. Mineral Wealth of the Southern Appalachian Region.—The great mineral wealth of the Southern States is chiefly located in the Southern Appalachian region. This includes a strip of elevated mountainous country many hundred of miles in length, and of an average width of 150 miles, which reaches from Pennsylvania southwesterly through Maryland, the Virginias, Kentucky, Tennessee, North and South Carolina, and into Alabama and Georgia. It is naturally divisible into three parallel strips of equal area. The southwestern strip runs from Pennsylvania to Alabama, and averages 50 miles in width. It is an unbroken coal field of over thirty-nine thousand square miles. The most valuable beds are found in West Virginia, Virginia, Kentucky and Tennessee, where the seams are thick and numerous; and the work of mining is simplified by the fact that the seams are mostly self-draining. In some of the Virginia and Kentucky mines are found seams of solid coal that are 6 to 8 feet, and in some cases 10 to 14 feet, thick. There is a great variety; block, cannel, and coking coal being found throughout this vast deposit. Some idea of its size can be formed from the statement that it contains forty times the amount of coal that existed in the virgin coal fields of Great Britain before a pick was struck. Great Britain has not yet begun to exhaust her stores; and with the Southern Appalachian field containing forty times the wealth of the British fields within her borders, the South possesses a bank of deposits upon which no successful "run" can ever be made. In this connection Mr. Wright quoted the report of Messrs. Cowlan and West, in which they say:

"With the wealth of the South piled up in its central region, with natural outlet northeast to the Chesapeake, southwest to the gulf, southeast to the Atlantic and northwest to the lakes, this great natural storehouse and workshop, the Southern Appalachian region has a foundation for the creation of wealth certainly equal to that of any portion of the world of like area."

II. Iron Industry.—In addition to the development of the coal mines, the South has seen a rapid development of her iron mines. In 1870 the total output of pig iron was only 184 540 tons. In 1890 it had risen to 1,780,909 tons. The South, however, does not possess much ore that is suitable for the Bessemer steel industry, though the State of Texas has recently shown some promising developments.

The average cost of 1 ton of pig iron in the Northern States is $14, whereas in the South it is only $10.75, and it is likely that this difference will increase rather than diminish. This is in part explained by the fact that the raw materials for manufacture are more advantageously grouped in the Southern States. The materials for the production of a given amount of iron can be assembled for manufacture in Northern Alabama for $1; whereas to assemble the same materials in the Northern States costs $5.

III. Cotton Industry.—The raising of cotton may be called the basic industry of the South.

Cotton crop in 1860	4,669,770 bales.
Cotton crop in 1871	4,352,000 "
Cotton crop in 1895	9,500,000 "

Since 1876 the annual production has invariably been greater than at any time prior to the war, and last year the total production reached 9,500,000 bales.

The amount of cotton consumed in Southern mills in 1885 was about 350,000 bales, and in 1895 double that amount was consumed. Not only has the total production doubled, but the value of the crop has been greatly increased by the introduction of improved machinery. The increase of the value of cottonseed oil in ten years is in round numbers $24,000,000.

IV. Transportation.—A reliable test of the industrial activity of a people may be found in the growth of its transportation facilities and the increase of travel. The mileage of Southern railroads was increased from 20,612 miles in 1880 to 46,900 miles in 1894.

	1880.	1890.
Total number of passengers carried	6,395,000	30,061,000
Total amount of freight moved	17,759,441	61,771,929
Total number of employes	37,000	90,000
Total earnings and income	47,000,000	103,000,000

The banking capital in the same interim has increased from $92,500,000 to more than $171,000,000—an increase of more than 86 per cent. The figures are large and conclusive; but a yet closer estimate of the genuine character of Southern prosperity is obtained from a study of the statistics of indebtedness. The total debt in 1880 was $215,712,241, whereas in 1890 this amount had been reduced to $178,162,786. These figures prove that the prosperity of the South is not on the surface or confined to the few, but that it is real and results from the material prosperity of the people.

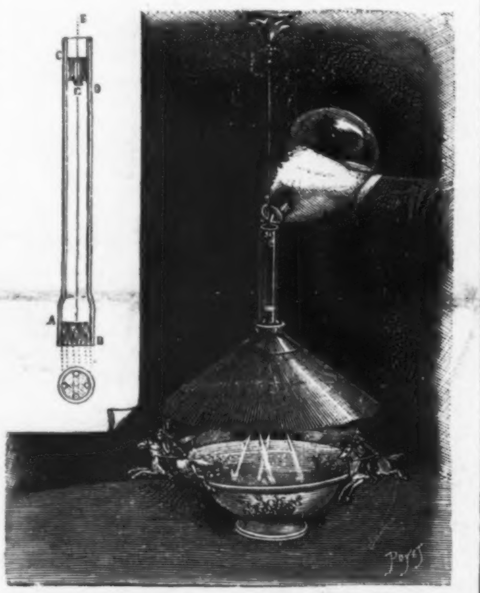
V. Education.—Turning from the question of material development, it may be asked: "Has the South progressed in other matters which are essential to the building up of a great people?" In the matter of education, it can be answered that the expenditure for school purposes has increased from $8,887,570 in 1878 to $16,806,668 in 1888. These figures show conclusively that educational development is keeping pace, relatively, with industrial growth. In 1880 the percentage of enrollment in the public schools was 16·59. In 1890 it had risen to 20·27, the percentage for the whole United States being 20·22.

In conclusion Mr. Wright stated that his lecture had dealt largely with statistics, for the reason that figures are more eloquent, when dealing with industrial affairs, than any other form of expression. They give in concrete form the results of great enterprises; they crystallize the moving history of the time. The inventory of the present industrial status of the South compared with that of a dozen years ago is at once eloquent of the actual results, and rich in future promise for that alliance of patience and activity which has characterized the history of her people.

* Supplementary lecture to the course on Social Statistics by Carroll D. Wright before the School of Social Economics, Union Square, New York. Specially reported for the SCIENTIFIC AMERICAN.

THE HYDRAULIC MERRY-GO-ROUND.

THE objects necessary for this experiment are a lamp chimney and shade and a couple of potatoes. Out of one of the potatoes cut a cylinder of the same diameter as the interior of the bottom and wide part of the chimney and about half the length of it. With a quill toothpick form four apertures in this cylinder oblique with respect to its axis. The section to the left of the accompanying figure shows the place and direction of these apertures. Insert the cylinder thus prepared into the bottom of the chimney. Into the top of the chimney insert another potato cylinder (or a cork) provided with three apertures of the same diameter as those in the lower cylinder (but in this case vertical instead of oblique), and a smaller aperture for



THE HYDRAULIC MERRY-GO-ROUND.

the passage of a suspension string, which must be attached to a piece of match under the top cylinder and fastened above to the chandelier that lights the table. Before the string is fastened to the chandelier, the lamp shade should be slid over the chimney after there has been suspended from its periphery, by means of thread, a number of figures mounted upon horses, cut out of paper or cardboard, and imitating the wooden animals and their living riders seen in merry-go-rounds.

A bowl having been placed upon the table beneath this device, it is only necessary to pour water into the top of the chimney in order to set the apparatus in operation. The liquid passes through the apertures on the upper cylinder, fills the chimney and flows out through the oblique orifices in the lower cylinder. As a consequence of the reaction, the entire affair will begin to revolve with considerable velocity.—Le Chercheur.

IRRIGATION BY WINDMILLS.

IT was found that in the Arkansas Valley water could be obtained by shallow wells ranging in depth from 8 to 20 feet. This is raised by hundreds of windmills into hundreds of small reservoirs constructed at the highest point of each farm. The uniform eastward slope of the plains is seven feet to the mile. The indefatigable Kansas wind keeps the mills in active operation, and the reservoirs are always full of water, which is drawn off as it is required for purposes of irrigation. These small individual pumping plants have certain advantages over the canal systems which prevail elsewhere. The irrigator has no entangling alliances with companies or co-operative associations, and is able to manage the water supply without deferring to the convenience of others or yielding obedience to rules and regulations essential to the orderly administration of systems which supply large numbers of consumers. The original cost of such a plant, exclusive of the farmer's own labor in constructing his reservoirs and ditches, is $200, and the plant sufficient for ten acres. The farmer thus pays $20 per acre for a perpetual guarantee of sufficient "rain" to produce bountiful crops; but to this cost must be added $2 per acre as the annual price of maintaining the system.—Century Magazine.

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